MASTERING ENVIRONMENTAL STRATEGY KNOWLEDGE: SEARCHING FOR THE PATH OF CORPORATE GREEN TRANSFORMATION IN THE CONTEXT OF CHINESE DIVERSIFIED ENVIRONMENTAL POLICIES

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(Received 18th Mar 2025; accepted 13th May 2025)

Abstract. As an important component of the market economy, enterprises should fully recognize the importance and urgency of sustainable development, and accelerate the process of green transformation. This article uses panel data from heavily polluting companies listed on the Shanghai and Shenzhen stock exchanges in China from 2011 to 2020 to study the impact of heterogeneous environmental regulations on corporate green transformation (CGT). The research results indicate on one hand that pollution discharge fees significantly inhibit, whereas environmental subsidies significantly promote CGT. On the other hand, the board size and marketization degree can significantly moderate the negative relationship between pollution discharge fees and CGT; however, neither can significantly enhance the positive relationship between environmental subsidies and CGT. Also, in enterprises with high equity concentration or low growth potential, the inhibitory effect of pollution discharge fees on CGT is more pronounced, while the positive effects of environmental subsidies on CGT are more evident. In addition, pollution discharge fees inhibit corporate environmental strategy and thus inhibit CGT; environmental subsidies strengthen the CGT by promoting their environmental strategies. From the results of group testing, it can be seen that the mediating role of environmental strategy between pollution discharge fees and CGT is only played in high equity concentration enterprises and low growth enterprises; the mediating role of environmental strategy between environmental subsidies and CGT is not affected by equity concentration and corporate growth. The research can provide effective references for the government to implement precise policies and enterprises to adjust strategies to jointly promote CGT.
Keywords: *pollution discharge fees, environmental subsidies, corporate social responsibility, corporate environment layout, synergy effect*

Introduction

Due to the rapid growth of global economy, the ecological environment has paid a significant price (Naseem et al., 2020). The adverse impacts of this situation are increasingly recognized and emphasized, making sustainable economic and social development a focal point of international concern and a guiding direction for countries worldwide (Wang et al., 2024a; Kashif et al., 2024a). The Chinese government supports that promoting green development in economic and social progress is crucial for achieving high-quality development, advocating for the clean and efficient utilization of energy, as well as the transformation of heavy-pollution sectors such as industry, construction, and transportation. However, it is thought-provoking that although the government has increased its efforts in environmental regulation from formulating laws and policies to issuing relevant regulations, environmental pollution incidents have not

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2402_21432175

decreased. Instead, there has been a surge in “black swan” and “grey rhino” events in the environmental sector, particularly affecting heavy-pollution industries such as chemical, paper manufacturing, and thermal power, with listed companies also being prominently involved. Therefore, in the context of increasingly diversified government environmental regulations, in-depth exploration of the evolution of corporate environmental strategies and the impact mechanism of corporate green transformation (CGT) is essential for improving the effectiveness of government green policies and enhancing the application of corporate environmental strategy knowledge.

The CGT refers to the process of changing traditional high-pollution and high-energy-consumption management practices towards a clean and environmentally friendly sustainable development model. This shift away from established patterns poses numerous challenges and risks for businesses; thus, external support and oversight are essential for successful green transformation. Currently, scholars have delved into external factors influencing green transformation, focusing primarily on three aspects: environmental policy, financing environment, and digitalization level. First, environmental policies, as a primary external force, have become a focal point of research. These policies exhibit diverse characteristics, such as mandatory environmental regulations, market-based environmental policies, and voluntary environmental policies, each with varying implementation effects and pathways (Li et al., 2024a). Some scholars have used comprehensive indicator systems to quantify the intensity of environmental regulation and study its impact mechanisms on CGT (Rogge and Schleich, 2018; Wang et al., 2022). Other researchers have focused on the policy effects of individual environmental regulations on CGT, such as environmental taxes (Shen and Zhang, 2022) and China’s carbon emissions trading pilot policies (Ge et al., 2023).

Secondly, the financing environment faced by enterprises is also a crucial factor in deciding whether to pursue CGT. Specifically, government-guided funds (Li et al., 2024b), green credit policies (Lin and Pan, 2024), and green finance (Naseem et al., 2024) can all accelerate the process of CGT. Finally, the rapid development of digital technologies provides new opportunities for CGT (Kashif et al., 2024b) and has gradually attracted attention from various sectors of society, leading to research exploring the relationship between digitalization levels and CGT. Guo et al. (2024) suggest that the “Broadband China” strategy can promote CGT by driving green technological innovation and easing financing constraints. Some scholars argue that corporate digital transformation can advance CGT (Miao and Zhao, 2023; Zhang et al., 2024), while others propose that the relationship between the two is U-shaped (Peng et al., 2022). Most of the above content considers the impact of external factors on CGT, but internal factors are equally worthy of attention. The rational “splitting” of top management teams based on information and knowledge (Peng et al., 2023), the heterogeneity of top management team career experiences (Gao et al., 2023), executive environmental awareness (Wang et al., 2024b) and ESG performance (Tan et al., 2024) can also facilitate CGT.

Previous studies have explored various factors influencing CGT from both external and internal perspectives, but how do heterogeneous environmental policies affect the CGT process? Can external heterogeneous environmental policies and internal corporate factors converge to drive CGT? Does the impact of heterogeneous environmental policies on CGT vary with changes in corporate characteristics? In a complex and dynamic policy environment, will companies adapt their environmental

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2402_21432175

strategies in a timely manner to seize opportunities and stand out in the competitive green market? There is little literature addressing these questions. Given that addressing the aforementioned issues is crucial for ensuring the smooth progression of CGT, the purpose of this study is to explore the impact of heterogeneous environmental regulations on CGT, analyze how internal and external factors collaborate to advance CGT, and delve into the mediating role of environmental strategy between environmental regulations and CGT. This research is a valuable addition to the field of CGT, providing insights for future environmental policy formulation and corporate strategic planning. It aims to enhance the alignment between environmental regulations and corporate development, thereby effectively promoting CGT outcomes.

This study's potential contributions can be summarized in several key aspects. First, current research primarily considers the overall intensity of environmental regulation or the impact of individual environmental policies on CGT, without comparative analysis of policies that may have opposing effects. This study examines the impacts of pollution discharge fees and environmental subsidies on CGT, helping to identify the differentiated effects of various environmental policies and how these effects change when multiple policies coexist. Second, this study employs both qualitative and quantitative methods to construct indicators for CGT from the perspectives of management transformation and technological transformation. This approach is closer to the essence of CGT compared to previous research that predominantly measures it through technological transformation alone. Third, this study analyzes the synergistic effects of internal factors (board size), external factors (marketization level), and both positive and negative environmental regulations (pollution discharge fees and environmental subsidies), revealing the mechanisms by which internal and external factors jointly influence CGT. This insight can aid in the formulation and implementation of more comprehensive and efficient environmental regulatory policies, providing robust support for CGT through internal and external linkages. Fourth, this research examines the effects of different environmental regulations on CGT across enterprises with varying levels of equity concentration and growth. This analysis helps reflect the diverse characteristics and impacts of environmental policies, providing decision-making references for governments to formulate more targeted regulatory policies and enhance policy effectiveness. Fifth, given that existing research has not considered how heterogeneous environmental regulations may lead to adjustments in corporate environmental strategies, thereby altering the effects of CGT, this study conducts an in-depth exploration of this issue. It emphasizes the importance of enterprises acquiring knowledge of environmental strategies to adapt to regulatory changes, thereby reducing the risks associated with transformation.

The remainder of the paper proceeds with a description of the materials and methods, an analysis of the results, a discussion of the findings, and concluding remarks.

Materials and methods

Theoretical analysis and research hypotheses

In 2003, the *Regulations on the Administration of the Collection and Use of Pollutant Discharge Fees* were passed, which clarified that China's pollution discharge fee system would transition from charging based on concentration to charging based on total emissions. The essence of pollution discharge fees is that enterprise funds are used for environmental protection and governance. However, in China, the pollution fee

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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collection standards are relatively low, only about 50% of the actual treatment costs (Hu et al., 2020), which is far lower than the governance cost, resulting in insufficient incentive effect. Additionally, the collection of pollution discharge fees may lead to a "crowding-out effect," which increases marginal costs and price markups for enterprises. Lan et al. (2017) found that the output value of enterprises was reduced after the adjustment of pollution discharge fee collection standards, resulting in a significant decrease in sulfur dioxide emissions of enterprises. However, this approach to emission reduction relies on decreasing pollution intensity and scaling back production (Hu et al., 2020). Furthermore, Wang et al. (2024c) found that pollutant discharge fees significantly inhibit corporate innovation and undermine their enthusiasm for environmental protection. It can be seen from this that the increase in pollution discharge fees leads to marginal costs exceeding marginal benefits. The main measures taken by enterprises are to reduce their scale and output in order to achieve pollution reduction. However, pollution fees are far lower than the cost of environmental governance, so companies would rather pay pollution fees than invest in advanced machinery and equipment, and use potential investment for innovation to pay pollution fees, which suppresses their green innovation and hinders their true green transformation (Blackman, 2009). Therefore, we propose the following hypothesis.

H1: Pollution discharge fees are not conducive to CGT.

Existing research by scholars on the impact of environmental subsidies on corporate development suggests that these subsidies play a positive role in promoting corporate growth. Li et al. (2024c) found that after receiving financial subsidies, enterprises are willing to increase their technological innovation capabilities and increase their awareness of environmental responsibility. Wang et al. (2024d) believe that in the long run, subsidies for environmental innovation costs facilitate enterprises in choosing green technological innovation models. Overall, environmental subsidies essentially serve as a critical means by which the government reallocates resources to facilitate CGT, and they provide support for enterprises in reducing emissions and pollution control (Li et al., 2024d). When enterprises receive government environmental subsidies, a "crowding-in" effect occurs, alleviating resource constraints and addressing resource shortages (Chen et al., 2014). This enables enterprises to invest in R&D of new products and technologies, thereby increasing their capability and confidence in management and technological transformation, ultimately facilitating green production. In addition, these enterprises will be subject to strict government supervision, and they must regularly disclose the direction and efficiency of fund use. The government will also evaluate and review the behavior of enterprises to avoid unfulfilled funds, which will reduce their pollution discharge behavior, increase their greenness, and the green transformation is just around the corner. Finally, in the eyes of investors, the fact that companies enjoy government environmental subsidies indicates that they have established a good relationship with the government (Wu and Cheng, 2011). According to the signal transmission theory, investors believe that companies deeply implement the government's environmental protection concept, so these companies will be favored by investors and attract them to invest. In order to win diversified support, companies will use funds for green transformation. Therefore, we propose the following hypothesis.

H2: Environmental subsidies positively influence CGT.

Green transformation is the most important decision for enterprises, which is related to their future and development. The board of directors is the core of corporate governance, and the results of its internal discussions may have a profound impact on the CGT. The

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board members have certain social experience and experience, and can make timely and effective responses based on policy perception (Wang et al., 2024b). For enterprises to pay pollution discharge fees, it is generally believed that it increases cost pressure and reduces expected output. However, the board of directors cannot take a short-sighted view and only pay pollution fees without fundamentally solving the problem. Given that innovation is the driving force behind corporate growth, only by changing existing emission reduction technologies can companies achieve green transformation and promote sustainable future development (Wang et al., 2025). Therefore, according to contract theory, a board of directors established on the basis of respect and trust can effectively supervise and coordinate the green transformation behavior of enterprises, and enhance the level of CGT. For companies receiving environmental subsidies, the board will convene meetings to discuss the situation, motivating enterprises to engage in self-reform and implement green management transformations to secure more subsidy benefits (Wang et al., 2023). On the other hand, the board aims to create a better green brand and environmental image, promote green innovation in enterprises, meet the green consumption needs of consumers, explore new markets on the basis of achieving group green consumption, and achieve comprehensive upgrading of CGT (Wang et al., 2024e). Therefore, we propose the following hypothesis.

H3a: The size of the board can alleviate the negative correlation between pollution discharge fees and CGT.

H3b: The size of the board can positively moderate the impact of environmental subsidies on CGT.

Marketization level is an important indicator for measuring economic development and transformation, and also reflects the market's ability to allocate resources (Li et al., 2025). At present, different levels of marketization in China have different regulatory effects on the CGT, and the impact of pollution discharge fees and environmental subsidies also varies. Pollution discharge fees and environmental subsidies are important means of market-driven environmental regulation. A higher marketization can provide a good external environment for CGT and compensate for the shortcomings of command based environmental regulation. Regions with a high degree of marketization indicate a solid economic foundation, and economic development is an opportunity for enterprises. Increasing market share through products reduces the operating cash flow pressure faced by enterprises, resulting in more profits compared to reducing production. Therefore, the negative impact of pollution discharge fees on the CGT is reduced. In addition, Li et al. (2024e) believe that in areas with high levels of marketization, not only are enterprises subject to strict supervision, but local environmental protection is also linked to government officials' assessments, which promotes green production and reduces emissions. Finally, as the information disclosure system improves, the transparency of environmental subsidy information increases, environmental protection subsidy information disclosure is fully open and transparent, and the government's coverage of environmental subsidy projects for enterprises is gradually expanding, further motivating CGT and strengthen enterprises' sense of responsibility. Therefore, we propose the following hypothesis.

H4a: The negative correlation between pollution discharge fees and CGT is mitigated as the level of marketization increases.

H4b: The positive correlation between environmental subsidies and CGT strengthens with higher levels of marketization.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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Given that the implementation of environmental regulations gradually leads to market greening, corporate entities must respond promptly to maintain market position and enhance competitiveness. Resource-based theory posits that corporations can effectively allocate and utilize internal resources (such as technology, managerial capabilities, and financial resources) through environmental strategies to address environmental policies, thereby strengthening their competitive advantage (Newbert, 2008). However, the complexity and diversity of environmental regulations can lead to unstable implementation effects, resulting in differentiated impacts on corporate environmental strategies. For example, environmental subsidies aim to encourage proactive environmental strategies through financial support, directly lowering investment costs in green technologies and sustainable projects (Eiadat et al., 2008). Once implemented, corporate environmental strategies create competitive advantages, particularly under conditions of high regulatory intensity, market dynamism, public concern, and competitive pressure (Leonidou et al., 2017). This is because such strategies not only meet regulatory oversight and incentives but also garner additional value from green innovation, enhancing public and environmental reputation, thus further promoting CGT (Yadav et al., 2017). Conversely, the primary purpose of pollution discharge fees is to incentivize pollution reduction, often perceived by corporations as a short-term economic burden, making them more inclined to maintain existing production modes. This tendency may lead corporates to adopt more conservative environmental strategies, being reluctant to risk costly green transformations (Li and Ma, 2022). Therefore, we propose the following hypothesis.

H5: Corporate environmental strategy acts as a mediator between environmental regulation and CGT.

H5a: Corporate environmental strategy acts as a mediator between pollution discharge fees and CGT.

H5b: Corporate environmental strategy acts as a mediator between environmental subsidies and CGT.

The theoretical analysis of environmental regulation and CGT is shown in *Figure 1*.

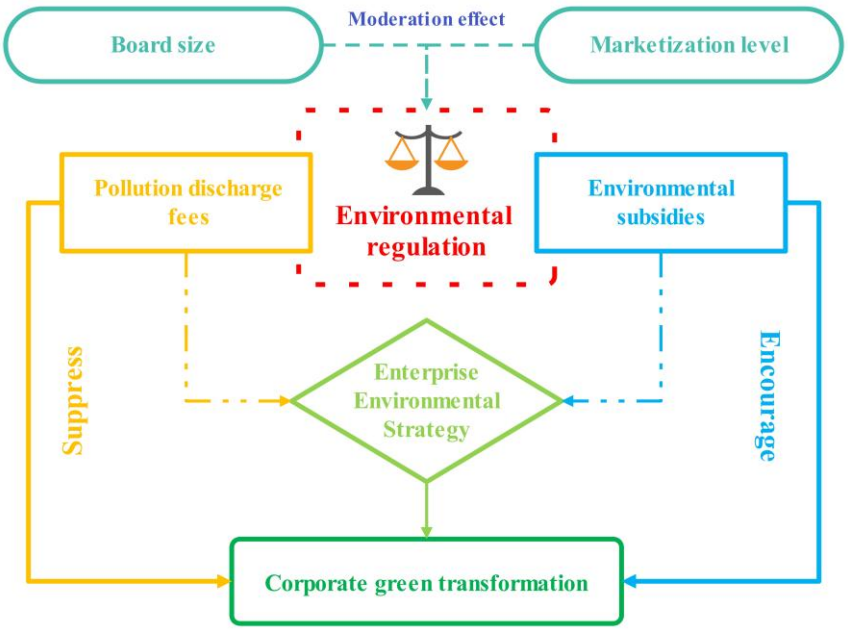

Figure 1. *Theoretical analysis of environmental regulation and CGT*

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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Sample selection and data sources

This article selects A-share industrial enterprises listed on the Shanghai and Shenzhen stock exchanges in China from 2011 to 2020 as research samples to empirically test the relationship between environmental regulations and CGT.

In terms of sample screening: (1) Identify heavily polluting industries. This article classifies industries with industry codes B06, B07, B08, B09, C17, C19, C22, C25, C26, C27, C28, C29, C30, C31, C32, C33, and D44 as heavily polluting industries according to the Classification of National Economic Industries (GB/T 4754-2017). The specific industry categories are as shown in *Table 1*. (2) Filter enterprises. In order to maintain the rationality and validity of the sample data, this article excludes the following types of enterprises: ST, * ST's continuous loss-making enterprises; enterprises with severe missing values; industrial enterprises listed after 2011; enterprises with zero pollution fees and environmental subsidies. There are a total of 128 enterprises.

Variable definition

Dependent variable

Corporate green transformation (CGT). At present, the indicators for measuring the CGT are diverse and there is no unified measurement standard. Based on previous research, it is generally believed that green transformation requires comprehensive innovation in concepts, management, technology, and systems as support. Therefore, this article draws on and refines the evaluation system for CGT constructed by Cheng and Wu (2024), dividing CGT into two aspects: green management transformation and green technology transformation, as shown in *Table 2*.

Green management transformation reflects the integration of green principles and green management, effectively ensuring the achievement of sustainable development goals and environmental strategies of enterprises. This, in turn, enhances the level of corporate green development and solidifies the foundation for long-term corporate growth. The transformation of green management demonstrates that enterprises have the initiative to undertake social responsibility, develop adaptive environmental plans, and conduct self-supervision. Therefore, the scope of measuring the green management transformation of enterprises in this article includes whether social responsibility reports are issued, whether environmental emergency plans are formulated, the self-monitoring of the environment, and whether environmental protection facilities are operating normally.

Green technology transformation is not only the core driving force of CGT, but also an important manifestation of the success of CGT. Because green technology innovation is fundamental to achieving green production and symbolizes a company's ability to address environmental issues. Advanced green technology can ensure the effective operation of enterprise transformation process and help enterprises gain a competitive edge in the green market. Based on the above analysis, this article incorporates green technology transformation into the indicator system and measures the degree of enterprise green technology transformation through the number of authorized green invention patents and green utility patents.

Finally, this article follows the approach of Karuppiah et al. (2020), using the Delphi method (expert scoring) and the capital-labor ratio to determine the weight distribution of the CGT indicators. The weight of green management transformation is set to 0.3, and the weight of green technology transformation is set to 0.7.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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Table 1. *Classification of heavily polluting industries*

Industry code	Industry category	Subcategory
B06	Coal mining and washing industry	Bituminous and anthracite coal mining and washing; Lignite mining and washing; Other coal mining
B07	Petroleum and natural gas extraction	Petroleum extraction; Natural gas extraction
B08	Ferrous metal mining and selection industry	Iron ore mining and selection; Manganese ore and chromium ore mining and selection; Other Ferrous Metal ore mining
B09	Non-ferrous metal mining and selection industry	Common non-ferrous metal ore mining and selection; Precious metal ore mining and selection; Rare and rare earth metal ore mining and selection
C17	Textile industry	Cotton spinning and dyeing finishing; Wool spinning and dyeing finishing; Hemp spinning and dyeing finishing; Silk spinning and dyeing finishing; Chemical fiber weaving and dyeing finishing; Knitted or crocheted fabric and product manufacturing; Household textile product manufacturing; Industrial textile product manufacturing
C19	Leather, fur, feather and their products, and footwear industry	Leather tanning and processing; Leather product manufacturing; Fur tanning and product processing; Feather (down) processing and product manufacturing; Footwear manufacturing
C22	Paper and paper products industry	Pulp manufacturing; Paper manufacturing; Paper product manufacturing
C25	Petroleum, coal and other fuel processing industry	Refined petroleum product Manufacturing; Coal processing; Nuclear fuel processing; Biomass fuel processing
C26	Chemical raw materials and chemical products manufacturing	Basic chemical Raw materials manufacturing; Fertilizer manufacturing; Pesticide manufacturing; Paints, inks, pigments and similar products manufacturing; Synthetic materials manufacturing; Specialized chemical product manufacturing; Explosives, pyrotechnics and fireworks product manufacturing; Daily chemical product manufacturing
C27	Pharmaceutical manufacturing	Chemical pharmaceutical raw material manufacturing; Chemical pharmaceutical formulation manufacturing; Chinese herbal medicine processing; Traditional Chinese medicine production; Veterinary pharmaceutical manufacturing; biological pharmaceutical product manufacturing; Medical materials and supplies manufacturing; Pharmaceutical auxiliary materials and packaging materials
C28	Chemical fiber manufacturing industry	Cellulose fiber raw materials and fiber manufacturing; Synthetic fiber manufacturing; Biobased materials manufacturing
C29	Rubber and plastic products industry	Rubber products industry; Plastic products industry
C30	Non-metallic mineral products industry	Cement, lime and gypsum manufacturing; Gypsum, cement products and similar products manufacturing; Brick, tile, stone and other building materials manufacturing; Glass manufacturing; Glass product manufacturing; Glass fiber and glass fiber reinforced plastic products manufacturing; Ceramic products manufacturing; Refractory materials manufacturing; Graphite and other non-metallic mineral products manufacturing
C31	Ferrous metal smelting and rolling processing industry	Iron smelting; Steel smelting; Steel rolling processing; Ferroalloy smelting
C32	Non-ferrous metal smelting and rolling processing industry	Common non-ferrous metal smelting; Precious metal smelting; Rare and rare earth metal smelting; Non-ferrous metal alloy manufacturing; Non-ferrous metal rolling processing
C33	Metal products industry	Structural metal product manufacturing; Metal tool manufacturing; Container and metal packaging manufacturing; Metal wire rope and product manufacturing; Building and safety metal product manufacturing; Metal surface treatment and heat treatment processing; Enamel products manufacturing; Metal daily necessities manufacturing; Casting and other metal products manufacturing
D44	Power, heat production and supply industry	Power production; Power supply; Heat production and supply

In terms of data sources: (1) The data on CGT is sourced from annual reports, sustainable development reports, social responsibility reports. (2) The data for the remaining variables are sourced from the CSMAR (https://data.csmar.com) database. In addition, to avoid the interference of extreme values on empirical research, this article conducted Winsorization on the corresponding continuous variables at the 1% and 99% percentiles

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Table 2. *Selection of green transformation indicators and variable assignments*

Representing dimensions	Variable name	Variable assignment
Green management transformation	Is a social responsibility report released	0-1
	Has an environmental emergency plan been developed	0-1
	Self-monitoring of the environment	0-1
	Whether the environmental protection facilities are operating normally	0-1
Green technology transformation	Number of green invention patent authorizations	/
	Number of green utility patent authorizations	/

In the quantitative scoring process, the first evaluation is based on whether the content of the indicator exists, with a score of 0 or 1. Taking whether a social responsibility report has been published as an example, if the enterprise has not published a social responsibility report, it will be recorded as 0 points, and if a social responsibility report has been published, it will be recorded as 1 point

Independent variable

Environmental regulations (ER). This article divides environmental regulations into two types. The first is pollution discharge fees, which charge companies for their pollution situation; The second is environmental protection subsidies, which refer to the government's rewards and subsidies for enterprises in environmental protection, including advanced energy-saving rewards, support funds for energy conservation and utilization, support funds for environmental protection standards, and subsidies for technological transformation.

Moderator variables

Board size (BOA). It is an important component of company management and plays an irreplaceable role in decision-making and supervision. This article uses the number of board members to measure the size of the board of directors.

The degree of marketization (MAR) is another moderating variable in this article. The degree of marketization represents the allocation of basic resources in a region, and also reflects the institutional laws and product market competition in that area. For example, if a company is located in a favorable institutional environment and has a relatively developed economy, it can formulate good response strategies in fierce competition, enhance strategic awareness and legal awareness. Therefore, this study uses the marketization index developed by the National Economic Research Institute (NERI) of China to measure the degree of marketization (Xie, 2017). The NERI index includes five sub-dimensions: government-market relations, private sector development, product-market development, factor market development, and the development of intermediary institutions and the legal environment.

Mediating variable

Environmental Strategy (ES). Environmental Strategy reflects the level of a firm's implementation of environmental strategies, measured through two key sub-dimensions: environmental management and environmental legitimacy. The environmental

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2402_21432175

management sub-dimension includes indicators such as environmental protection goals, environmental management certification systems, environmental management institutions, and environmental education and training expenses. The environmental legitimacy sub-dimension includes indicators such as the application for pollution discharge permits, whether the company has been penalized for environmental violations, the impact of new environmental regulations on business operations, and whether the company has received environmental rewards (Li, 2019). The indicators for environmental strategy are assigned values of 0 or 1, following the same principles used for green transformation. The environmental strategy index is then calculated as the ratio of a company's total score across eight environmental strategy items to the sum of the scores for the best-performing environmental strategy items.

Control variables

Finally, this study selects the following variables as control variables. (1) Corporate size (SIZE): Larger corporations typically have more resources and capabilities for green transformation, thus influencing their responses to environmental regulations. (2) Leverage (LEV): A higher level of debt may limit a corporation's investment capacity, affecting its input and ability to transition to green technologies. (3) Separation of two positions (TV): The separation of the roles of Chairman and CEO can impact decision-making efficiency, thereby influencing the corporation's green transformation strategies and execution. (4) Capital intensity (CAP): Capital-intensive corporations may respond differently to environmental regulations due to the longer payback periods on fixed asset investments. (5) Financing constraints (FIN): A corporation's financing capability directly impacts its ability to make green investments. This study employs the KZ method to calculate the degree of financial constraints and constructs the SA index using firm size and age, as follows: SA = -0.737 * Size + 0.043 * Size² - 0.04 * Age (Hadlock and Pierce, 2010). (6) Age of listing (AGE): Corporations that have been listed for a longer period may have more maturity in experience and resources, leading to stronger adaptability to environmental regulations. (7) Manager agency costs (AGEN): Agency issues may affect managerial decisions, thus influencing the corporation's response to environmental regulations and decisions related to green transformation. (8) Development capability (DEV): A corporation's capacity for development determines its receptiveness and adaptability to new technologies and green transformation. The detailed descriptions of the variables are provided in *Table 3*.

Methods

By integrating the basic ideas of theoretical analysis and drawing on existing relevant research, this article sets the following models for the impact of environmental regulations on CGT:

$$CGT = \alpha_0 + \alpha_1 ER1_{it} + \alpha_2 Control_{it} + \varepsilon_{1it} \quad \text{(Eq.1)}$$

$$CGT = \beta_0 + \beta_1 ER2_{it} + \beta_2 Control_{it} + \varepsilon_{2it} \quad \text{(Eq.2)}$$

$$CGT = \chi_0 + \chi_1 ER1_{it} + \chi_2 BOA_{it} + \chi_3 ER1_{it} * BOA_{it} + \chi_4 Control_{it} + \varepsilon_{3it} \quad \text{(Eq.3)}$$

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$$CGT = \delta_0 + \delta_1 ER2_{it} + \delta_2 BOA_{it} + \delta_3 ER2_{it} * BOA_{it} + \delta_4 Control_{it} + \varepsilon_{4it} \quad \text{(Eq.4)}$$

$$CGT = \phi_0 + \phi_1 ER1_{it} + \phi_2 MAR_{it} + \phi_3 ER1_{it} * MAR_{it} + \phi_4 Control_{it} + \varepsilon_{5it} \quad \text{(Eq.5)}$$

$$CGT = \varphi_0 + \varphi_1 ER2_{it} + \varphi_2 MAR_{it} + \varphi_3 ER2_{it} * MAR_{it} + \varphi_4 Control_{it} + \varepsilon_{6it} \quad \text{(Eq.6)}$$

$$ES = \eta_0 + \eta_1 ER1_{it} + \eta_2 Control_{it} + \varepsilon_{7it} \quad \text{(Eq.7)}$$

$$CGT = \zeta_0 + \zeta_1 ER1_{it} + \zeta_2 ES_{it} + \zeta_3 Control_{it} + \varepsilon_{8it} \quad \text{(Eq.8)}$$

$$ES = \lambda_0 + \lambda_1 ER2_{it} + \lambda_2 Control_{it} + \varepsilon_{9it} \quad \text{(Eq.9)}$$

$$CGT = \mu_0 + \mu_1 ER2_{it} + \mu_2 ES_{it} + \mu_3 Control_{it} + \varepsilon_{10it} \quad \text{(Eq.10)}$$

In the formula: i represents the enterprise; t represents time; α_0, β_0, χ_0, δ_0, ϕ_0, φ_0, η_0, ζ_0, λ_0, μ_0 is the common intercept; The coefficients α, β, χ, δ, ϕ, φ, η, ζ, λ, μ are the regression coefficients for the respective variables; *Control* represents control variables, including *SIZE*, *LEV*, *TV*, *CAP*, *FIN*, *AGE*, *AGEN*, *DEV*; ε is a random perturbation term.

Table 3. *Descriptions of the variables*

Variable properties	Variable name	Variable code	Calculation method
Dependent variable	Corporate green transformation	CGT	Composite index of green management transformation and green technology transformation
Independent variable	Pollution discharge fees	ER1	Pollution discharge fees divided by operating income
	Environmental subsidies	ER2	Environmental subsidies divided by operating income
Moderator variables	Board size	BOA	Number of directors
	Marketization level	MAR	Marketization index
Mediating variable	Environmental strategy	ES	Content analysis method
Control variables	Enterprise size	SIZE	Take the logarithm of operating income
	Leverage	LEV	Total liabilities divided by total assets
	Separation of two positions	TV	Is the General Manager and Chairman separated
	Capital intensity	CAP	Fixed assets divided by operating income
	Financing constraints	FIN	SA = -0.737 * Size + 0.043 * Size² - 0.04 * Age
	Age of listing	AGE	Subtract the year of the company's listing from the current year
	Manager agency costs	AGEN	Management expenses divided by operating income
	Development capability	DEV	Rate of capital accumulation

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2402_21432175

The Ordinary Least Squares (OLS) regression model reveals the linear relationship between independent and dependent variables, enhancing model accuracy and explanatory power by introducing control variables. This method is widely used in social sciences and economics, aiding researchers in understanding the interactions and mechanisms among variables. Therefore, models (1) and (2) are constructed to examine the relationships between pollution discharge fees, environmental subsidies, and CGT. The moderation effect model is an effective approach to analyze complex relationships between variables, focusing on how the impact of independent variables on dependent variables varies under different conditions, particularly how moderating variables influence this relationship. To explore the moderating effects of board size on the relationship between pollution discharge fees and CGT, as well as its role in enhancing the effect of environmental subsidies on CGT, models (3) and (4) are constructed for testing. Additionally, to analyze the moderating effects of marketization level on pollution discharge fees and CGT, as well as its role in enhancing the effect of environmental subsidies on CGT, models (5) and (6) are constructed for testing.

The mediation effect model is an effective method for analyzing the relationship between independent and dependent variables, focusing on how this relationship is realized through mediating variables. This model examines the impact of the independent variable on the mediating variable, as well as how the mediating variable further influences the dependent variable, thereby revealing the indirect relationships among variables. This approach enables a deeper understanding of causal mechanisms, enhances theoretical explanatory power, and provides guidance for intervention strategies in practice. To investigate whether environmental strategy has such effects between pollution discharge fees and CGT, models (7) and (8) are constructed for testing. Additionally, to explore whether environmental strategy plays a similar role between environmental subsidies and CGT, models (9) and (10) are constructed for testing.

Results

Descriptive statistics

To better explain the stability and dispersion characteristics of the variables, this study employs STATA 16 software to conduct statistical analysis on the indicators between various variables, with the results presented in *Table 4*.

Overall, the minimum and maximum values for CGT are 0 and 24.50, with a variance of 1.5, indicating significant and uneven differences in green transformation among sample firms. Furthermore, the average of CGT is lower than the median, suggesting that most companies have not prioritized the implementation of green transformation and are performing poorly in this regard. The minimum value of pollution discharge fees is 0, and the maximum value is 18.40, reflecting notable variability in the payment of these fees among enterprises, fundamentally linked to the quantity of pollutant equivalents emitted by each company. The variance of environmental subsidies is 0.92, with a maximum value of 22.97 and a minimum value of 0, indicating a significant difference between companies receiving environmental subsidies. The median is 0.03 and the average is 0.26, indicating that the average is higher than the median, which indicates that most enterprises recognize the important role of environmental subsidies in facilitating their green transformation.

From the perspective of controlling variables, the average size of the enterprise is 22.16, with a median of 22.05 and a small variance of 1.26, indicating that the overall

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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size of the enterprise is relatively close. The minimum and maximum values of the debt to asset ratio are 0.02 and 2.99, respectively, with a median of 49% and an average of 48%. This suggests that most companies are operating at a high debt level, indicating significant risk, and they should be vigilant about operational risks. The variance of the separation of two positions is 0.38, indicating that this indicator is relatively stable. The separation of CEO and chairman of the board is beneficial for the company to improve management efficiency. The average and median of capital intensity are similar, indicating that most enterprises have invested in advanced machinery and equipment to improve labor productivity, while matching the heavy asset characteristics of heavily polluting industries. The minimum value of financing constraints is -18.46, the maximum value is -14, and the difference between the maximum and minimum values is relatively small, with a variance of 0.94, indicating that the entire heavy polluting industry will be subject to financing constraints and face relatively consistent problems. The variance of the age at which companies go public is 5.33, indicating that there is a significant gap in listing between heavily polluting companies, resulting in differences in resources between companies. This is because the length of time at which companies go public provides assistance in achieving their green transformation. The median and average of agency costs for managers are basically consistent, indicating that most companies maximize their benefits through entrusted agency, and managers are also motivated to gain control benefits through achieving green transformation of the enterprise. The average value of a company's development capability is 1.12, while the median is 1.05, suggesting that the growth potential of most companies has not reached the average level. Therefore, companies should have foresight, attach importance to long-term development, and not lose overall awareness for short-term benefits. Overall, the vast majority of enterprises operate within their normal business scope.

Table 4. *Descriptive statistics*

	MEAN	SD	P25	P50	P75	MIN	MAX	N
CGT	1.070	1.650	0.300	0.900	1.200	0	24.50	1280
ER1	0.220	0.700	0.0300	0.100	0.220	0	18.40	1280
ER2	0.260	0.920	0	0.0300	0.140	0	22.97	1280
SIZE	22.16	1.260	21.33	22.05	23.05	17.30	25.88	1280
LEV	0.480	0.210	0.320	0.490	0.630	0.0200	2.990	1280
TV	1.820	0.380	2	2	2	1	2	1280
CAP	0.720	0.510	0.370	0.590	0.940	0.0700	3.150	1280
FIN	-16.08	0.940	-16.72	-16.02	-15.45	-18.46	-14	1280
AGE	17.59	5.330	14	18	21	2	34	1280
AGEN	0.0700	0.0500	0.0300	0.0600	0.0900	0.0100	0.280	1280
DEV	1.120	0.310	1	1.050	1.140	0.550	2.940	1280

Correlation analysis

This article conducts correlation analysis on various variables with the aim of reducing multicollinearity issues and making the results objective and truthful. According to *Table 5,* the absolute values of the correlation coefficients are all below 0.5, indicating that there is no multicollinearity problem among the variables.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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In the Pearson correlation analysis, the correlation between CGT and variable ER1 reflecting pollution discharge fees shows a significant negative relationship at the 10% level, with a correlation coefficient of -0.043. In contrast, CGT is positively correlated with the variable ER2 reflecting environmental subsidies at the 1% level, with a correlation coefficient of 0.089. In terms of controlling variables, enterprise size, separation of two positions, and age of listing demonstrate significant positive relationships with CGT. However, the correlation coefficient between managerial agency costs and CGT is -0.147, which is significantly negative at the 1% level. Although there are positive correlations among asset liability ratio, capital intensity, financing constraints, and development capability, these correlations are not statistically significant.

In the Spearman correlation analysis, the correlation coefficient between pollution discharge fees and CGT is -0.114, which is significant at the 1% level. The environmental subsidy also shows a significant positive correlation with CGT at the 1% level, with a correlation coefficient of 0.035. The comparison of these two correlation methods reveals substantial differences in the relationship between the main variables, laying a foundation for further research. From the relationship between CGT and control variables, the regression coefficients for enterprise size, separation of two positions, and age of listing are 0.303, 0.165, and 0.137, respectively, all significantly positive at the 1% level. The correlation coefficient between capital intensity and CGT is 0.035, which is significantly correlated at the 10% level. Financing constraints and manager agency costs are negatively correlated with CGT at 1% level, indicating that green transformation with high financing constraints and manager agency costs is relatively slow to achieve. The asset liability ratio and the development ability are positively correlated with their green transformation, but their relationship is not significant.

Table 5. *Correlation analysis between environmental regulations and corporate green transformation*

	CGT	ER1	ER2	SIZE	LEV	TV	CAP	FIN	AGE	AGEN	DEV
CGT	1	-0.114***	0.035***	0.303***	0.038	0.165***	0.035*	-0.311***	0.137***	-0.214***	0.087
ER1	-0.043*	1	0.108***	-0.259***	-0.034	-0.180***	0.290***	0.249***	-0.082***	0.294***	-0.051*
ER2	0.089***	0.039***	1	-0.145***	0.068**	-0.048*	0.219***	0.098***	0.146***	0.116***	-0.061**
SIZE	0.247***	0.215***	-0.156***	1	0.466***	0.183***	-0.154***	-0.965***	0.213***	-0.590***	0.101***
LEV	0.034	0.047***	0.027***	0.454***	1	0.069**	0.206***	-0.480***	0.149***	-0.286***	-0.181***
TV	0.109***	-0.110*	0.100**	0.187***	0.070**	1	-0.049*	-0.189***	0.086***	-0.173***	-0.054*
CAP	0.040	0.111***	0.049***	-0.186***	0.177***	-0.041	1	0.118***	0.104***	0.272***	-0.121***
FIN	0.021	0.186**	-0.145	-0.968***	-0.469***	-0.191***	0.145***	1	-0.412***	0.579***	-0.077***
AGE	0.035**	0.052	0.050***	0.244***	0.195***	0.074***	0.127***	-0.449***	1	-0.155***	-0.033
AGEN	-0.147***	-0.257**	-0.080***	-0.544***	-0.201***	-0.168***	0.281***	0.525***	-0.113***	1	-0.065**
DEV	0.036	-0.26**	-0.053	-0.010	-0.134***	-0.041	-0.030	0.026	-0.067**	-0.037	1

*, * *, and * * * respectively indicate significance at the 10%, 5%, and 1% confidence levels, t-statistics in parentheses, as below

Benchmark regression

The regression results to verify whether the impact of environmental regulations on CGT proposed in the hypothesis is valid are presented in *Table 6*. Columns (1) and (2) show the effects of pollution discharge fees and environmental subsidies on the CGT without adding control variables, respectively, while columns (3) and (4) illustrate these effects with control variables included.

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In terms of pollution discharge fees and CGT, please refer to columns (1) and (3) for details. Column (1) indicates a negative correlation between pollution discharge fees and CGT at the 10% significance level. In column (3), after including control variables, the correlation coefficient for pollution discharge fees and CGT is -0.035, and the significance level improves to 1%. This suggests that pollution discharge fees have a detrimental effect on CGT activities, thus confirming hypothesis H1. From the perspective of controlling variables, the correlation coefficient between asset liability ratio and CGT is -0.799, which is significantly negatively correlated at the 1% level. This indicates that in the process of achieving CGT, excessive borrowing by enterprises leads to high risk and uncertainty. That is, the higher the asset liability ratio, the lower the possibility of achieving CGT. In contrast, enterprise size, separation of roles, financing constraints, and age of listing are all significantly positively correlated with CGT.

Table 6. *Benchmark regression of environmental regulation and corporate green transformation*

	CGT			
	(1)	**(2)**	**(3)**	**(4)**
ER1	-0.016* (-1.68)		-0.035*** (-3.57)	
ER2		0.024*** (2.87)		0.015* (1.78)
SIZE			0.324*** (6.45)	0.292*** (5.85)
LEV			-0.799*** (-3.39)	-0.886*** (-3.73)
TV			0.380*** (3.24)	0.415*** (3.53)
CAP			0.069 (0.24)	-0.053 (-0.18)
FIN			2.628*** (4.67)	2.464*** (4.37)
AGE			0.103*** (4.31)	0.099*** (4.11)
AGEN			-0.551 (-0.54)	-0.496 (-0.48)
DEV			-0.030 (-0.22)	-0.012 (-0.08)
_cons	1.117*** (7.86)	0.598*** (5.32)	6.441*** (3.29)	5.518*** (2.82)
N adj.R-sq	1280 0.002	1280 0.007	1280 0.105	1280 0.097

In terms of environmental subsidies and CGT, please refer to columns (2) and (4) for details. From column (2), it is evident that environmental subsidy ER2 is significantly correlated with CGT at the 1% level, with a correlation coefficient of 0.024. In column (4),

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after including control variables, the significance of the positive correlation between environmental subsidies and CGT noticeably decreases; however, it still supports the validity of H2. The reason is manifested in: firstly, the asset liability ratio, reflecting the enterprise's debt capacity, shows a significant negative correlation at the 1% level, which is detrimental to the enterprise's sustainable development. Secondly, the regression coefficient between capital intensity and CGT is -0.053. Enterprises have not strengthened their attention to fixed assets and have not substantially invested in clean production equipment, but have only invested in general machinery and equipment. Thirdly, the agency cost of managers is negatively correlated with the CGT, but not significant, indicating that managers, driven by short-term interests, pursue higher personal interests and are unwilling to increase investment, believing that the benefits of investment may be recovered in the coming years. In addition, the scale of the enterprise, separation of roles, financing constraints, and age of listing are all conducive to the realization of CGT.

Robustness test

Change the measurement method of independent variables

This article takes the logarithm of pollution discharge fees and environmental subsidies, denoted as ER11 and ER22 respectively, and re-regresses the model. The results indicate that ER11 is significantly negatively correlated with CGT at the 10% level, while ER22 is significantly positively correlated with CGT at the 10% level, demonstrating the robustness of the findings.

Overcoming information disclosure bias

Although we included a large number of control variables in our regression analysis to account for other influencing factors. However, the targets of corporate information disclosure are government, investors, and other entities, therefore, corporate environmental information disclosure behavior will affect the capital market. Therefore, this article only retains samples where pollution discharge fees and environmental subsidies coexist to eliminate interference factors in information disclosure. *Table 7* reveals that the pollution discharge fees is significantly negatively correlated with CGT at the 1% level, while the regression coefficient for environmental subsidies is 0.051, which is significantly positively correlated at the 5% level, confirming the validity of the selected indicators.

Moderation effect analysis

Environmental regulation, board size, and corporate green transformation

To verify whether corporate environmental regulation and board size can jointly promote CGT, this study introduces interaction terms between environmental regulation and board size for further examination. Specifically, Column (1) in *Table 8* presents the combined effects of pollution discharge fees and environmental subsidies on CGT. It indicates that pollution discharge fees are significantly negatively correlated with CGT at the 1% level, while environmental subsidies are significantly positively correlated with CGT at the 10% level, establishing a foundation for investigating their moderating effects on the relationship between environmental regulation and CGT. Columns (2) and (3) respectively examined the moderating effects of board size on pollution discharge fees and CGT, as well as environmental subsidies and CGT. The interaction

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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term results indicate that moderating effect of board size on pollution discharge fees and CGT was significantly negatively correlated at the 1% level, suggesting that larger boards enhance the negative impact of pollution discharge fees on CGT. Conversely, the moderating effect of board size on the relationship between environmental subsidies and CGT is not significant. The above results indicate that hypotheses H3a and H3b do not hold. The possible reasons might be that as the board size increases, the decision-making process may become more complex and slower, leading to reduced decision-making efficiency. This hampers the company's ability to quickly adjust its strategies in response to environmental regulations, further weakening the effectiveness of CGT. Additionally, companies receiving environmental subsidies may excessively cater to government demands, neglecting their own innovation and development efforts. Column (4) reflects the joint moderating effect of board size on pollution fees and CGT, as well as environmental subsidies and CGT. It can be seen that the coefficient of the ER*BOA is significant at the 1% level, while the coefficient of ER2*BOA is not significant. This indicates that the moderating effect of board size on the relationship between pollution discharge fees and CGT is more pronounced.

Table 7. *Robustness test results*

	CGT			
	(1)	**(2)**	**(3)**	**(4)**
ER11	-0.041* (1.00)			
ER22		0.013* (0.26)		
ER1			-0.051*** (-1.42)	
ER2				0.051** (2.14)
SIZE	0.319*** (5.87)	0.303*** (5.64)	0.274*** (4.84)	0.226*** (4.35)
LEV	-0.957*** (-3.62)	-0.863*** (-3.40)	-0.507** (-2.19)	-0.575** (-2.48)
TV	0.416*** (3.54)	0.422*** (3.58)	0.381*** (3.18)	0.382*** (3.20)
CAP	-0.015 (-0.05)	-0.030 (-0.10)	-0.327 (-1.07)	-0.505* (-1.73)
FIN	2.287*** (3.83)	2.443*** (4.18)	3.164*** (5.70)	2.919*** (5.32)
AGE	0.092*** (3.63)	0.099*** (3.92)	0.121*** (5.14)	0.111*** (4.73)
AGEN	-0.729 (-0.70)	-0.567 (-0.55)	-0.765 (-0.65)	-0.936 (-0.81)
DEV	-0.021 (-0.15)	-0.008 (-0.06)	-0.005 (-0.04)	-0.007 (-0.05)
_cons	4.944** (2.37)	5.501*** (2.68)	8.857*** (4.34)	7.119*** (3.58)
N	1280	1280	787	787
adj.R-sq	0.095	0.094	0.124	0.127

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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Table 8. *Regression results on the moderating effect of board size*

	CGT			
	(1)	**(2)**	**(3)**	**(4)**
ER1	-0.036*** (-3.70)	0.592*** (3.89)		0.609*** (3.98)
ER2	0.016* (1.88)		-0.058 (-0.56)	-0.102 (-0.99)
ER1*BOA		-0.288*** (-4.13)		-0.296*** (-4.23)
ER2*BOA			0.033 (0.70)	0.054 (1.15)
BOA	0.231 (0.84)	4.550*** (4.25)	-0.208 (-0.33)	3.970*** (3.42)
SIZE	0.304*** (5.75)	0.328*** (6.21)	0.277*** (5.21)	0.320*** (6.04)
LEV	-0.845*** (-3.57)	-0.862*** (-3.68)	-0.873*** (-3.67)	-0.898*** (-3.81)
TV	0.357*** (3.00)	0.377*** (3.20)	0.411*** (3.44)	0.389*** (3.27)
CAP	0.049 (0.17)	0.090 (0.31)	-0.058 (-0.20)	0.075 (0.26)
FIN	2.501*** (4.34)	3.176*** (5.33)	2.282*** (3.85)	3.056*** (5.05)
AGE	0.098*** (4.02)	0.127*** (5.03)	0.092*** (3.67)	0.121*** (4.75)
AGEN	-0.603 (-0.59)	0.120 (0.12)	-0.630 (-0.61)	0.124 (0.12)
DEV	-0.043 (-0.30)	-0.071 (-0.51)	-0.015 (-0.11)	-0.075 (-0.54)
_cons	5.629*** (2.65)	-1.792 (-0.65)	5.556** (2.42)	-0.995 (-0.35)
N adj.R-sq	1280 0.107	1280 0.119	1280 0.096	1280 0.122

Environmental regulation, degree of marketization, and corporate green transformation

To verify whether environmental regulation and the degree of marketization can jointly promote CGT, the research introduces interaction terms between environmental regulation and marketization for further analysis. The column (1) in *Table 9* shows the combined impact of pollution discharge fees and environmental subsidies on CGT. The results show that pollution discharge fees are significantly negatively correlated with CGT at the 1% level, while environmental subsidies are significantly positively correlated with CGT at the 10% level, laying the foundation for studying the moderating effect between environmental regulations and CGT. Columns (2) and (3) respectively examined the moderating effects of marketization on pollution discharge

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fees and CGT, as well as environmental subsidies and CGT. From the results of the interaction term, it was found that the moderating effect of marketization on pollution discharge fees and CGT was significantly negatively correlated at the 5% level, indicating that marketization can enhance the negative impact of pollution fees on CGT. Conversely, the moderating effect of marketization on the relationship between environmental subsidies and CGT is not significant. The above results indicate that hypotheses H4a and H4b do not hold. Column (4) reflects the joint moderating effect of marketization on pollution discharge fees and CGT, as well as environmental subsidies and CGT. It can be seen that the coefficient of ER1*MAR is significant at the 1% level, while the coefficient of ER2*MAR is not significant, indicating that the moderating effect of marketization on the relationship between pollution discharge fees and CGT is more pronounced.

Table 9. *Regression results on the moderating effect of marketization degree*

	CGT			
	(1)	**(2)**	**(3)**	**(4)**
ER1	-0.035***	0.055		0.054
	(-3.62)	(1.47)		(1.42)
ER2	0.015*		0.012	0.012
	(1.89)		(0.42)	(0.42)
MAR	0.096***	0.260***	0.095*	0.253***
	(4.09)	(3.69)	(1.84)	(3.12)
ER1*MAR		-0.012**		-0.012**
		(-2.46)		(-2.43)
ER2*MAR			0.000	0.000
			(0.05)	(0.10)
SIZE	0.337***	0.338***	0.312***	0.332***
	(6.74)	(6.77)	(6.25)	(6.65)
LEV	-0.660***	-0.673***	-0.692***	-0.721***
	(-2.76)	(-2.82)	(-2.87)	(-3.00)
TV	0.426***	0.435***	0.468***	0.427***
	(3.63)	(3.72)	(3.99)	(3.65)
CAP	-0.026	-0.070	-0.130	-0.081
	(-0.09)	(-0.24)	(-0.45)	(-0.28)
FIN	2.571***	2.710***	2.422***	2.688***
	(4.61)	(4.85)	(4.31)	(4.79)
AGE	0.093***	0.100***	0.090***	0.099***
	(3.89)	(4.17)	(3.72)	(4.11)
DEV	-0.038	-0.044	-0.013	-0.049
	(-0.27)	(-0.31)	(-0.09)	(-0.35)
AGEN	-0.306	-0.266	-0.296	-0.225
	(-0.30)	(-0.26)	(-0.29)	(-0.22)
_cons	5.294***	4.651**	4.509**	4.560**
	(2.70)	(2.35)	(2.29)	(2.30)
N	1280	1280	1280	1280
adj.R-sq	0.121	0.123	0.110	0.125

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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Heterogeneity test

Heterogeneity analysis based on equity concentration

The concentration of equity plays an important role in creating value. Some studies have shown that appropriate equity concentration can balance and supervise the behavior of managers, reduce agency costs, and promote the development of enterprises. Environmental regulation serves as an external supervision mechanism for enterprises. Can internal managers of enterprises respond to environmental regulations without harming shareholder interests and promoting sustainable development of the enterprise? Therefore, this study uses the median of equity concentration for grouping to examine the impact of pollution discharge fees on CGT and the relationship between environmental subsidies and CGT within this grouping.

Table 10 shows that the correlation coefficient between high equity concentration and CGT in column (1) is -0.056, which is significant at the 1% level. Column (2) represents the impact of low equity concentration on CGT, with a correlation coefficient of -0.015 but not significant. The regression coefficient did not pass the test. The inhibitory effect of pollution discharge fees on the CGT with high equity concentration is more significant. The essence of pollution discharge fees is to require enterprises to forcibly pay such fees, otherwise they will be punished. The CGT requires a long time to achieve, and shareholders will intervene too much with managers in their daily business processes to avoid embarrassing their own interests, changing the company's development strategy, and thus putting the transformation activities on hold. In addition, high equity concentration leads to excessive concentration of information in the hands of the largest shareholder, resulting in information asymmetry and an increase in the company's debt ratio, leading to a deterioration of the company's financial situation and a lack of funds and capabilities for green transformation. In terms of controlling variables, the regression coefficient of enterprise size in column (1) is 0.442, which is greater than the enterprise size coefficient of 0.345 in column (2), indicating that among enterprises with high equity concentration, enterprise size can alleviate the negative correlation between pollution discharge fees and CGT. Compared to column (2), the regression coefficient of the asset liability ratio in column (1) is larger and significantly negatively correlated at the 1% level, indicating that under high equity concentration, the asset liability ratio will exacerbate the negative correlation between pollution discharge fees and CGT. The coefficient for the separation of the two positions in column (1) is 0.379, which is significant at the 0.05 level. However, it is smaller than the regression coefficient of 0.492 for the separation of the two positions in column (2), which is significant at the 0.01 level. This indicates that the separation of two positions in low equity concentration enterprises can promote the CGT to a certain extent. The regression coefficients of capital intensity in columns (1) and (2) are not significant, indicating that regardless of the level of equity concentration, the capital intensity of heavily polluting enterprises does not significantly impact CGT. The coefficients of financing constraints, listing period, manager agency cost, and development ability in column (1) have not passed the test. The regression coefficient of financing constraints and listing years in column (2) is significant at the 0.01 level, that is, financing constraints with low equity concentration and listing years can alleviate the inhibition of pollution discharge fees on the CGT, indicating that enterprises with low equity concentration can fully utilize their existing social reputation for multi-channel fundraising. The correlation coefficient of managerial agency cost in column (2) is -

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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2.436, which is significantly negatively correlated at the 1% level, indicating that agency costs are higher in enterprises with low equity concentration, and major shareholders are difficult to form effective deterrence, thus negatively impacting the CGT. The regression coefficient of development capability in column (2) did not pass the test, indicating that the relationship between development capability and CGT with low equity concentration is not significant.

Table 10. *Heterogeneity analysis based on equity concentration*

	CGT			
	(1)	**(2)**	**(3)**	**(4)**
	High	**Low**	**High**	**Low**
ER1	-0.056***	-0.015		
	(-3.84)	(-1.23)		
ER2			0.017*	0.010
			(1.34)	(0.94)
SIZE	0.442***	0.345***	0.392***	0.330***
	(5.28)	(5.59)	(4.66)	(5.39)
LEV	-1.371***	-0.516*	-1.478***	-0.569**
	(-3.44)	(-1.86)	(-3.63)	(-2.05)
TV	0.379**	0.492***	0.414**	0.516***
	(1.97)	(3.53)	(2.13)	(3.73)
CAP	0.457	-0.280	0.409	-0.375
	(0.97)	(-0.81)	(0.86)	(-1.10)
FIN	-0.792	4.346***	-1.010	4.266***
	(-0.79)	(6.92)	(-0.99)	(6.81)
AGE	-0.029	0.165***	-0.036	0.163***
	(-0.68)	(6.02)	(-0.84)	(5.95)
AGEN	2.217	-2.436**	1.855	-2.304**
	(1.20)	(-2.11)	(0.99)	(-1.99)
DEV	-0.313	0.180	-0.244	0.172
	(-1.49)	(1.01)	(-1.15)	(0.96)
_cons	-4.771	11.255***	-6.043*	10.804***
	(-1.36)	(5.15)	(-1.70)	(4.98)
N	637	642	637	642
adj.R-sq	0.080	0.219	0.056	0.218

Columns (3) and (4) report the impact of environmental subsidies on the CGT. The regression coefficient for environmental subsidies in column (3) is significantly 0.017 at the 10% level, while the regression coefficient of environmental subsidies in column (4) did not pass the test. Ultimately, compared to enterprises with low equity concentration, the increase in environmental subsidies for enterprises with high equity concentration is beneficial for the improvement of their green transformation. Because the largest shareholder has a certain degree of control over the board of directors, selects strong managers to participate in the company's business decisions, formulates green environmental policies and strategies, enhances government

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2402_21432175

recognition of corporate green behavior, and thus increases subsidies to enterprises. On the other hand, shareholder concentration can reduce the free riding phenomenon of other small shareholders and lower the agency costs between shareholders and managers. In terms of controlling variables, both enterprise size and job separation positively impact CGT at the 1% level. Specifically, the regression coefficient of enterprise size in column (3) is greater than that in column (4), indicating that enterprises with high equity concentration have a certain scale effect and can accelerate the process of CGT. The regression coefficient for the separation of two positions in column (3) is smaller than that in column (4), indicating that although the separation of two positions in enterprises with different levels of equity concentration can positively promote the positive correlation between environmental subsidies and green transformation, this effect is stronger in enterprises with low equity concentration. The asset liability ratio in columns (3) and (4) has a negative impact on the green transformation of heavily polluting enterprises, especially in suppressing the positive effect of environmental subsidies for high equity concentration enterprises on their green transformation.

Heterogeneity analysis based on enterprise growth

Growth is the ability of a company to continuously add value, representing its sustainable development ability and reflecting its comprehensive productivity across all factors. It is specifically manifested in the growth of profitability and the appreciation of intangible assets. Based on this, this study uses the revenue growth rate as a measure and employs the median of corporate growth rate (0.06) to classify firms into high-growth and low-growth categories. It then tests the impact of pollution discharge fees on corporate green transformation (CGT) and the relationship between environmental subsidies and CGT within these groups. *Table 11* presents the heterogeneity analysis of corporate growth.

Columns (1) and (2) describe the impact of pollution discharge fees on CGT under different growth stages. In the high growth group, the impact of pollution discharge fees on the CGT is not significant; In the low growth group, the regression coefficient of pollution discharge fees is -0.069, which is significant at the 1% level, indicating a negative correlation between pollution discharge fees and CGT with low growth. Based on the coefficients of two sets of pollution discharge fees, it can be concluded that compared to high growth enterprises, the pollution discharge fees of low growth enterprises have a more significant inhibitory effect on their green transformation. This is because high growth enterprises have relatively complete management mechanisms and fast market expansion speed, which enables them to pay pollution discharge fees and achieve ideal green transformation.

In addition, Columns (3) and (4) represent the relationship between government subsidies and CGT under different growth stages. The regression coefficient for environmental subsidies in column (3) is 0.005, which did not pass the test, while the regression coefficient for environmental subsidies in column (4) is 0.023, which passed the test at the 10% significance level. Ultimately, compared to enterprises with high growth potential, environmental subsidies for enterprises with low growth potential are more conducive to the improvement of their green transformation. This may be due to two reasons: First, high-growth enterprises that receive environmental subsidies do not necessarily pursue economic benefit maximization; rather, they are often driven by a broader sense of social responsibility, contributing to national ecological development

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2402_21432175

and effectively serving community environmental management. As a result, these efforts are unlikely to lead to significant short-term impacts on green transformation. In contrast, low-growth enterprises prioritize survival and cost reduction, placing economic benefits at the forefront. They strive to enhance their environmental practices in order to secure government subsidies and allocate resources efficiently.

Table 11. *Heterogeneity analysis based on enterprise growth*

	CGT			
	(1)	**(2)**	**(3)**	**(4)**
	High	**Low**	**High**	**Low**
ER1	-0.001	-0.069***		
	(-0.11)	(-4.36)		
ER2			0.005	0.023*
			(0.55)	(1.67)
SIZE	0.281***	0.342***	0.278***	0.284***
	(4.44)	(4.46)	(4.42)	(3.69)
LEV	-0.337	-1.186***	-0.351	-1.361***
	(-1.09)	(-3.37)	(-1.13)	(-3.79)
TV	0.482***	0.249	0.479***	0.335*
	(3.61)	(1.26)	(3.61)	(1.68)
CAP	-0.196	0.390	-0.201	0.183
	(-0.59)	(0.81)	(-0.61)	(0.37)
FIN	1.854**	3.258***	1.881**	2.910***
	(2.08)	(4.16)	(2.11)	(3.66)
AGE	0.073**	0.126***	0.074**	0.117***
	(1.98)	(3.71)	(2.01)	(3.37)
AGEN	-1.456	1.234	-1.410	0.985
	(-1.26)	(0.70)	(-1.22)	(0.55)
DEV	0.088	-0.110	0.089	-0.124
	(0.53)	(-0.49)	(0.54)	(-0.54)
_cons	3.580	9.016***	3.621	7.175**
	(1.23)	(3.15)	(1.25)	(2.48)
N	638	642	638	642
adj.R-sq	0.102	0.120	0.102	0.092

Further analysis

As can be seen from the previous text, pollution discharge fees inhibit the CGT, and environmental subsidies promote the CGT through incentive mechanisms. Why do pollution discharge fees and environmental subsidies have a completely different impact on the CGT? When enterprises face different pressures from the government, they will adjust their internal strategic decisions to adapt to external changes. Enterprises will engage in two different behaviors, namely catering to the government or motivating themselves, to fulfill legitimacy and social responsibility requirements. When facing the government, environmental strategy is often used as an important internal decision for

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2402_21432175

enterprises. According to the theoretical hypothesis analysis mentioned earlier, environmental strategy may play a mediating role between environmental regulation and CGT. This section will examine the mediating effect of environmental strategy and provide a detailed analysis of its role in different contexts, such as varying levels of ownership concentration and corporate growth.

Mediation effect test

Table 12 presents the results of examining the mediating role of environmental strategy between environmental regulation and CGT. Among them, columns (1), (2) and (3) reflect the mediating role of environmental strategy between pollution discharge fees and CGT. In column (1), pollution discharge fees significantly inhibit the CGT, consistent with previous regression results, indicating that the prerequisite for the mediating effect is valid. In column (2), the regression coefficient between pollution discharge fees and corporate environmental strategy is -0.003, which is significant at the 5% level. In column (3), pollution discharge fees show a significant negative correlation with CGT at the 1% level; the regression coefficient between environmental strategy and CGT is 1.435, significantly positively correlated at the 1% level, and the SOBEL coefficient passes the test. This indicates that environmental strategy plays a partial mediating role between the two, that is, the pathway of "pollution discharge fees − inhibiting environmental strategy − inhibiting CGT" exists, thereby supporting H5a.

Columns (4), (5) and (6) reflect the mediating role of environmental strategy in environmental subsidies and CGT. In column (4), environmental subsidies significantly promote the CGT, consistent with the previous regression results, indicating that the prerequisite for the mediating effect is valid. In column (5), environmental subsidies are negatively correlated with CGT at the 10% level, with a regression coefficient of -0.003. In column (6), the coefficient between environmental subsidies and CGT did not pass the test; the regression coefficient between environmental strategy and CGT is 1.395, which is significantly positively correlated at the 1% level, but the SOBEL coefficient is significant at the 10% level. The above results indicate that environmental strategy plays a completely mediating role between the two, that is, the path of "environmental subsidies − promoting environmental strategy − strengthening CGT" exists, thereby supporting H5b.

Mediation effect test based on equity concentration grouping

Table 13 shows the results of the equity concentration grouping test for the mediating effect of environmental strategy on pollution discharge fees and CGT. Column (1) shows that pollution discharge fees have a significant negative impact on the CGT, indicating that the mediating effect test is based on the presence of high equity concentration enterprises. Column (2) indicates that pollution discharge fees have a significant negative impact on environmental strategy, significant at the 0.1 level. In column (3), environmental strategy has a positive impact on CGT that is significant at the 1% level, while the negative impact of pollution discharge fees on the CGT still exists, indicating that environmental strategy has played a partial mediating role. In low equity concentration enterprises, column (4) shows an insignificant negative correlation between pollution discharge fees and the CGT, indicating no mediating effect. Overall, the mediating role of environmental strategy between pollution discharge fees and CGT is only evident in high equity concentration enterprises.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2402_21432175

Table 12. *The mediating role of environmental strategy on environmental regulation and corporate green transformation*

	CGT	ES	CGT	CGT	ES	CGT
	(1)	(2)	(3)	(4)	(5)	(6)
ER1	-0.035***	-0.003**	-0.030***			
	(-3.57)	(-2.45)	(-3.13)			
ER2				0.015*	0.002*	0.011
				(1.78)	(1.77)	(1.32)
ES			1.435***			1.395***
			(6.52)			(6.31)
Control	YES	YES	YES	YES	YES	YES
_cons	-4.032***	-0.138*	-3.834***	-4.645***	-0.240***	-4.306***
	(-6.75)	(-1.65)	(-6.54)	(-7.66)	(-2.84)	(-7.20)
N	1280	1280	1280	1280	1280	1280
adj.R-sq	0.100	0.146	0.135	0.102	0.153	0.135
SOBEL Z			-1.932*			1.702*
SOBEL P			0.053			0.089

Table 13. *The mediating effect of environmental strategies on pollution discharge fees and corporate green transformation, based on equity concentration grouping*

	CGT	ES	CGT	CGT	ES	CGT
	(1)	(2)	(3)	(4)	(5)	(6)
	High equity concentration			Low equity concentration		
ER1	-0.054***	-0.003*	-0.050***	-0.013	-0.003*	-0.006
	(-3.77)	(-1.70)	(-3.53)	(-1.01)	(-1.67)	(-0.53)
ES			1.254***			1.683***
			(3.57)			(6.24)
Control	YES	YES	YES	YES	YES	YES
_cons	-2.830***	-0.327***	-2.420***	-5.720***	0.103	-5.888***
	(-3.23)	(-2.98)	(-2.77)	(-7.10)	(0.80)	(-7.56)
N	637	637	637	642	642	642
adj.R-sq	0.087	0.187	0.108	0.153	0.121	0.211
SOBEL Z			-1.397*			-1.2
SOBEL P			0.093			0.230

Table 14 shows the results of the equity concentration grouping test for the mediating effect of environmental strategy on environmental subsidies and CGT. In enterprises with high equity concentration, there is no significant positive correlation between environmental subsidies and green transformation, indicating the absence of a mediating effect. In low equity concentration enterprises, column (4) shows an insignificant negative correlation between environmental subsidies and CGT, indicating no mediating effect. The above results indicate that the mediating role of environmental strategy between environmental subsidies and CGT is not affected by the concentration of equity.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2402_21432175

Table 14. *The mediating effect of environmental strategies on environmental subsidies and corporate green transformation, based on equity concentration grouping*

	CGT	ES	CGT	CGT	ES	CGT
	(1)	(2)	(3)	(4)	(5)	(6)
	High equity concentration			Low equity concentration		
ER2	0.020	0.001	0.019	0.011	0.003*	0.006
	(1.61)	(0.88)	(1.49)	(1.07)	(1.75)	(0.60)
ES			1.327***			1.681***
			(3.74)			(6.23)
Control	YES	YES	YES	YES	YES	YES
_cons	-3.174***	-0.347***	-2.714***	-5.727***	0.102	-5.889***
	(-3.60)	(-3.17)	(-3.09)	(-7.11)	(0.79)	(-7.57)
N	637	637	637	642	642	642
adj.R-sq	0.066	0.184	0.090	0.153	0.121	0.212
SOBEL Z			0.752			1.76*
SOBEL P			0.452			0.078

Mediation effect test based on growth grouping

Table 15 presents the results of the growth grouping test of enterprises on the mediating effect of environmental strategy between pollution discharge fees and CGT. In companies with high growth potential, although pollution discharge fees may inhibit CGT, this effect does not pass the significance test, indicating that the basis for the mediating effect is not present. In companies with lower growth potential, the regression coefficient between pollution fees and green transformation is -0.048, which is significant at the 1% level, indicating that the prerequisite for the mediating effect is valid. In column (5), there is a significant negative correlation between pollution discharge fees and the CGT. In column (6), both pollution discharge fees and environmental strategies show significant effects on CGT at the 1% level, indicating that environmental strategy plays a partial mediating role between pollution discharge fees and CGT. Thus, the mediating effect of environmental strategy between pollution discharge fees and CGT only plays a role in enterprises with lower growth potential.

Table 16 presents the results of the mediating effect of environmental strategy between environmental subsidies and CGT, categorized by enterprise growth. In companies with high growth potential, environmental subsidies have a negative impact on CGT, but this relationship does not pass the significance test, indicating that the basis for the mediating effect is not present. In enterprises with low growth potential, the regression coefficient between environmental subsidies and green transformation is 0.021, which is significant at the 5% level, indicating that the prerequisite for the mediating effect is valid. In column (5), there is no significant relationship between environmental subsidies and the CGT. In column (6), both pollution discharge fees and environmental strategy show a positive and significant effect on CGT, but the SOBEL Z-value is 1.497, failing the significance level test. Therefore, the mediating effect of environmental strategy between environmental subsidies and CGT is not influenced by corporate growth.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2402_21432175

Table 15. *The mediating effect of environmental strategy on pollution discharge fees and corporate green transformation, based on their growth grouping*

	CGT	**ES**	**CGT**	**CGT**	**ES**	**CGT**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	High enterprise growth potential			**Low enterprise growth potential**		
ER1	0.001	-0.003	0.005	-0.048***	-0.004**	-0.043***
	(0.07)	(-1.19)	(0.34)	(-4.05)	(-2.24)	(-3.66)
ES			1.470***			1.369***
			(3.79)			(5.11)
Control	YES	YES	YES	YES	YES	YES
_cons	-4.885***	-0.200	-4.591***	-3.686***	-0.095	-3.557***
	(-4.27)	(-1.17)	(-4.09)	(-5.24)	(-0.98)	(-5.14)
N	638	638	638	642	642	642
adj.R-sq	0.082	0.120	0.123	0.115	0.165	0.144
SOBEL Z			-1.024			-1.796*
SOBEL P			0.306			0.072

Table 16. *The mediating effect of environmental strategies on environmental subsidies and corporate green transformation, based on grouping of corporate growth*

	CGT	**ES**	**CGT**	**CGT**	**ES**	**CGT**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	High enterprise growth potential			**Low enterprise growth potential**		
ER2	-0.004	0.002	-0.007	0.021**	0.002	0.018*
	(-0.29)	(1.08)	(-0.54)	(2.03)	(1.51)	(1.75)
ES			1.474***			1.423***
			(3.80)			(5.29)
Control	YES	YES	YES	YES	YES	YES
_cons	-4.888***	-0.211	-4.578***	-3.869***	-0.109	-3.710***
	(-4.28)	(-1.23)	(-4.09)	(-5.46)	(-1.13)	(-5.32)
N	638	638	638	642	642	642
adj.R-sq	0.082	0.120	0.123	0.100	0.162	0.132
SOBEL Z			0.841			1.497
SOBEL P			0.400			0.134

Discussion

As countries increasingly focus on balancing economic growth with environmental sustainability, promoting corporate green development has become a crucial topic of discussion. Existing research primarily evaluates corporate green development through the lens of green technology innovation, often measured by the number of green patents (Yu et al., 2024; Song et al., 2024). Given that corporate green development represents a transformation away from traditional high-pollution and high-energy-consumption production and management models, this article employs the concept of CGT to explore strategies for promoting green development, measuring it through composite indicators of green management transformation and green technology transformation.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2402_21432175

Additionally, some scholars have used composite indicators to assess the strength of environmental regulations and their impact on corporate green development (Ma et al., 2022; Fan et al., 2022). Considering that different environmental regulations may yield varying effects, this study focuses on pollution discharge fees and environmental subsidies to offer practical insights for the formulation of diverse environmental policies.

The research findings indicate that pollution discharge fees significantly hinder CGT, which contrasts with Li et al. (2019), whose study suggests a U-shaped relationship between pollution discharge fees and CGT of steel industry. The differing conclusions may arise from variations in sample selection and time periods. Conversely, environmental subsidies notably promote CGT, aligning with the results of Wei et al. (2024), who assert that environmental subsidies facilitate green development. Moreover, regardless of the implementation of pollution discharge fees or environmental subsidies, factors such as enterprise size and financing constraints can influence the CGT, a finding supported by previous research (Tingbani et al., 2021).

Additionally, given that internal and external factors may synergistically interact with environmental regulations, the study explores the moderating effects of board size and marketization. The results indicate that both factors can jointly affect CGT alongside pollution discharge fees, but show no significant synergistic effect with environmental subsidies. This contrasts with the findings of Zhao et al. (2022), who found that board size demonstrates a promoting effect on green technological innovation, possibly due to the diversity characteristics of the board (Elmagrhi et al., 2019; Naveed et al., 2023). Heterogeneity analysis results reveal that, compared to firms with low ownership concentration, pollution discharge fees have a more pronounced inhibiting effect on the CGT with high ownership concentration, while increased environmental subsidies are more beneficial for the CGT of high ownership concentration firms. In terms of firm growth potential, pollution discharge fees exert a stronger inhibiting effect on the CGT of low-growth firms compared to high-growth firms, while environmental subsidies are more advantageous for the CGT of low-growth enterprises. This contrasts with the views of some scholars who argue that high-growth firms are better able to fulfill social responsibilities, thereby promoting CGT (Ben-Amar et al., 2017; Lin and Pan, 2024). The differing perspectives may be attributed to our consideration of the impact of the external policy environment.

Regarding the pathways through which environmental regulations influence corporate green development, previous research has primarily focused on aspects such as executive compensation (Li and Li, 2024), managers' green cognition (Tang et al., 2023), and managerial opportunism (Chen and Chen, 2024). Considering that the implementation of environmental policies affects corporate strategy adjustments and subsequently influence CGT, this study incorporates corporate environmental strategy into the analysis to enhance research in this area. The results demonstrate that environmental strategy serves as a 'bridge' between pollution discharge fees and CGT, as well as between environmental subsidies and CGT. Furthermore, unlike previous studies, this article further explores the heterogeneous characteristics of the mediating effect of environmental strategy. The results indicate that the mediating role of environmental strategy between pollution discharge fees and CGT varies with ownership concentration and growth potential, whereas the mediating effect between environmental subsidies and CGT does not exhibit these characteristics.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2402_21432175

Conclusion

In light of resource depletion and increasingly severe environmental issues, researching ways to achieve CGT has become urgent. This study uses data from listed companies in heavily polluting industries in China from 2011 to 2020 to empirically analyze how different environmental regulations adjust corporate environmental strategies and subsequently impact CGT. The findings are as follows: (1) Pollution discharge fees significantly inhibit CGT, while environmental subsidies notably promote it. Hypotheses H1 and H2 are confirmed. (2) Both board size and marketization levels interact with pollution discharge fees to influence CGT, specifically showing that they positively moderate the negative effect of pollution discharge fees on CGT. Hypothesis H3a is validated, while Hypothesis H4a is not supported. Additionally, neither board size nor marketization shows significant synergy with environmental subsidies, and Hypotheses H3b and H4b are not supported. (3) The impacts of pollution discharge fees and environmental subsidies on CGT exhibit heterogeneous characteristics. Specifically, the inhibiting effect of pollution discharge fees and the promoting effect of environmental subsidies on CGT are more pronounced in firms with high ownership concentration and low growth potential. (4) Environmental strategy plays a partial mediating role between pollution discharge fee policies and CGT. Thus, Hypothesis H5a is confirmed. And environmental strategy serves as a complete mediator between environmental subsidy policies and CGT. Therefore, Hypothesis H5b is validated. Additionally, in the heterogeneous analysis of mediating effects, the mediating role of environmental strategy between pollution discharge fees and CGT is only evident in firms with high ownership concentration and low growth potential, while its mediating effect between environmental subsidies and CGT is unaffected by ownership concentration and firm growth.

Author contributions. Liping Wang: Formal analysis, Supervision, Review & editing, Project administration. Longjun Chen: Resources, Writing – original draft, Formal analysis, Validation. Ziting Yao: Data curation, Methodology, Writing – original draft, Formal analysis. Chuang Li: Conceptualization, Review & editing, Funding acquisition, Formal analysis.

Funding. The research is supported by the National Social Science Fund of China (24FJYB037) and the Innovation Strategy Research Plan Project of Fujian Province (2025R0046).

Conflict of interests. 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.

Data availability. Data will be made available on request.

Ethical approval. This study conforms to the ethical and moral requirements.

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