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Sustainable green financial system perspective of environmental protection investment and the government's environmental policy or public participation: evidence from Chinese A-share listed companies

Lisi Zhang[a], Ziwei Zhang[b], Karolina Bieryt[c] and Summiya Aftab[d]

[a]School of International Economics and Politics, Liaoning University, Shenyang, China; [b]School of Economics, Liaoning University, Shenyang, China; [c]Institute of Nuclear and New Energy Technology, Tsinghua University, Beijing, China; [d]Government Degree College, Thana, Batkhela, Pakistan

ABSTRACT

Corporate environmental protection investment (EPI) is one of the ways to accelerate green development. This paper develops a theoretical model of EPI focusing on three factors: the government, the public, and the enterprises. It uses data from A-share listed Chinese companies from 2008 to 2014 to analyse the effects of the government environmental policy and public participation on the corporate EPI. Results of this research show that both the environmental regulations issued by the government and the demands put forward by public opinion encourage enterprises to increase investment in environmental protection. Moreover, the government's green policy efforts and public participation result in synergy in governance. Relevant regulations issued by the government improve the efficiency of actual public participation. However, redundant government intervention is not conducive to increasing corporate investment in environmental protection. According to this research, market-oriented reforms can boost the positive impact of government and public efforts on corporate EPI. In order to improve environmental governance and achieve green development, it is necessary to deepen market-oriented reforms and build a coordinated, complementary, and incentive-compatible governance system that deals with issues, demands, rights, and responsibilities of the government, the public, and enterprises.

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Green development; Government policy; Public participation; Corporate environmental protection investment

JEL CODES
H2; G3; Q5

1. Introduction

Investments and financial markets are imperative to achieve the goals of green development, and they are considered essential factors in achieving carbon neutrality (Berger, 2022; Umar et al., 2021; Xu et al., 2022; Yuan et al., 2022). The massive contagion of the new coronavirus (Covid-19) has affected economic development and people's lives,

CONTACT Ziwei Zhang ziweilnu@163.com

disrupting enterprises' normal operations. Restrictive movements have led to stalled production, dragged on demand, and ultimately resulted in an immense drag on enterprises' revenues and cash flows (Mirza et al., 2023). These are bound to affect corporate investment in green development (Ferrat et al., 2022; Gao et al., 2021). Naqvi et al. (2021) found that during Covid-19, the performance of green funds degraded, highlighting the additional investment drag. The government should take governance and regulatory interventions to promote a sustainable financial system. Chinese green funds perform is better than other countries (Ielasi et al., 2018). This is due to China's multiple eco-friendly economic policies over the years (Huang, 2022; Ji et al., 2021; Umar et al., 2022).

The environment is seen as a public resource; the whole society shares the cost of environmental pollution. As production is the main source of environmental pollution (Ji et al., 2019), and pollution control investment is not heavily conducted with the help of the local government's fiscal expenditure system, environmental protection investment (EPI) largely depends on corporate investment (Azapagic & Perdan, 2000; He, 2003). Solely depending on market mechanisms to solve the problem has failed and requires targeted government actions (Hmaittane et al., 2019; Huang, 2019; Kaiser & Welters, 2019). If government incentives and guidelines can motivate enterprises to increase investment in environmental protection and simultaneously not lead to a market failure? Many researchers have investigated this issue with inconsistent conclusions. The proponents of the government should take measures actively point out that mandatory emission limits, environmental taxes (Safi et al., 2021), tradable emission permits, and voluntary agreements (Chang et al., 2021; Peng et al., 2021), and other environmental regulations increase the cost of pollution for enterprises. Hence, enterprises increase their investment in pollution alleviation to maximise profits and meet higher environmental standards (Fullerton & Heutel, 2017; Li & Du, 2022). However, some scholars believe that the government's regulations are ineffective and state that the local governments favour short-term gains, which are often combined with unnecessary administrative interference, corruption, and excessive expansion of the scope of regulation. These hinder the reduction of emissions by companies (Keech & Munger, 2015; Song et al., 2018). It is precisely because the existing research has not classified government behaviour, leading to inconsistent conclusions. This paper will improve this further, dividing government behaviour into two categories and studying the impact on enterprise environmental protection investment.

To a certain extent, the public should be given the power of decision in environmental governance, which should be ensured by environmental laws and regulations (Xiao et al., 2013). Public opinion demands cannot be ignored while achieving green development. One of the examples proving the above statement is the experience learned by the government from large-scale protests in Xiamen in 2007, Dalian in 2011, and Maoming in 2014, which were related to public reaction to para-xylene pollution. The events pressure the central and local governments to include residents' interests and environmental concerns in their plans. As a result, the controversial industrial projects in Xiamen and Dalian were relocated. Public governance theory believes that cooperation with the public is an effective way to solve market and government issues in environmental governance (Fike & Gwartney, 2015; Liu et al., 2019). Many empirical studies also conclude that public participation positively improves environmental governance (Farzin & Bond,

2006; Kathuria, 2007; Warwick & Ortolano, 2007; Zheng et al., 2014). However, some researchers state that the public participation mechanism is still far from perfect in some regions. In many developing countries, the prevalent 'top-down' environmental governance systems (Hasan et al., 2018; Ogihara et al., 2016) result in public participation having no significant impact on the efficiency of environmental governance. Whether public participation can increase corporate investment in environmental protection (Wu et al., 2018) and whether the government's policy influences the effectiveness of public governance still need further research, both in theoretical and practical aspects.

Furthermore, speaking about the impact of government policy and public opinion on the EPI, the role of the institutional environment in the country cannot be ignored (Ji et al., 2021; Khan et al., 2022; Mirza et al., 2023; Safi et al., 2021). Especially since the Chinese opening-up policy was launched in 1978 and has gradually been carried out, China has been advancing institutional reforms in the socio-economic and political fields. The influences of regional differences in marketisation level on government effectiveness and public governance are relatively few and need further analysis. Existing literature provides an important reference basis for this study. Still, there is no generalised theoretical model of the mutual influence of the government, the public, and enterprises concerning the EPI was constructed. Existing empirical tests were provincial and prefecture-level cities, and a few were performed with SMEs as samples. Moreover, no study investigated the influence of market-oriented institutional changes on the efficiency of the government and public activity concerning environmental governance in China.

In particular, the goals of this study are the following. First, we use A-share listed Chinese company samples from 2008 to 2014 to analyse the effects of the government environmental policy and public participation on the corporate EPI. Then we estimate the synergy effect and test the impact of market-oriented reform on corporate EPI. Finally, we put forward feasible suggestions according to the conclusion of this study. The contributions of this paper are listed as follows: first, we take enterprises, government, and the public into the common research framework and develop a theoretical model to investigate the influence mechanism of government's environmental regulations, government intervention, public participation, and their synergy effects on corporate EPI. Second, we study the impact of the improvement of the institutional environment represented by the market-oriented reform in China on the behaviour of multiple micro-subjects to provide research demonstration for promoting the modernisation of the national governance system in the context of environmental protection.

This paper is organised as follows. Section 2 puts forward the theoretical model and a research hypothesis. Section 3 describes the empirical design, and Section 4 presents the empirical results. Section 5 provides further analysis, and Section 6 concludes with some policy implications.

2. Theoretical model and research hypothesis

2.1. Model construction

Following (Cole et al., 2006; Damania et al., 2003; Deng et al., 2019), this paper makes the following basic assumptions about the model subjects. The local government utility comes from regional economic growth, public happiness, and rent-seeking income.

Public happiness partly comes from improved living standards linked with regional economic growth and partly from improved environment quality associated with increased corporate EPI. Companies organise production based on profit maximisation and invest in environmental protection according to their output. Enterprises can choose to lobby the local government to relax regulations and thus reduce corresponding EPI.

The specific behaviour assumptions about enterprises, the public, and the government are as follows.

2.1.1. Assumptions about the enterprises

The model assumes only one company in the specific region, whose output Q contributes to the entire GDP of the region, and the product price is normalised to 1. The marginal cost is $c(c < 1)$, with no fixed costs, but the environmental management fee aQ must be paid according to the output. If the enterprise lobbies the local government with bQ to obtain environmental regulation relaxation X, then the profit function of the enterprise is $\pi = Q - cQ - bQ - \alpha(Q - X)$.

2.1.2. Assumptions about the public participation

It is assumed that public utility comes from two aspects. First, it comes from the regional economic growth, resulting in, e.g., income improvement and municipal infrastructure quality. Second, it is determined by the environmental governance standards, which depend on the EPI. The public attaches weights to these two types of utility as γ and $1\text{-}\gamma$, respectively. The public utility function is $U_{public} = \gamma Q + (1 - \gamma)\alpha(Q - X)$.

2.1.3. Assumptions about the government

With a deep understanding of the people-oriented governance concept in China, the performance assessment of local governments is no longer solely based on GDP. The pursuit of citizens' happiness (represented, e.g., by environmental quality) has expanded the scope of the performance assessment. Since the *11th Five-Year Plan* in 2006, pollution reduction has been set as an indicator for measuring local government officials' performance. This model assumes that the performance assessment of the local government officials includes two aspects, regional economic growth, and regional public happiness. Variables λ and $1\text{-}\lambda$ are assigned to two of the factors, respectively. The variables reflect the strategic goals of the central government for economic development. In addition, this model assumes that enterprise rent-seeking bQ is one of the utility sources of the local government. The utility function of the local government is $U_{govern} = bQ + \lambda Q + (1 - \lambda)U_{public}$.

It is assumed that the local government's objective function is $E(U_{govern}) = (1 - P)U_{govern}\ P = p_0\alpha X$. The function describes the probability of the local government's opportunistic behaviour being detected, where p_0 represents the condition of the regional legal system and the degree of advancement of intermediary organisations. The intermediary organisations are one of the market-oriented indicators drawn by the NERI Marketisation Index of China's Provinces. The degree of advancement of the intermediary organisations includes the service conditions of market intermediary organisations such as lawyers and accountants and the extent of help provided by industry associations to enterprises (Wang et al., 2017). αX is the scale of relaxation of

environmental regulations that the local government must follow. The higher values of p_0 and αX, the higher the probability of the local government's opportunistic behaviour being discovered.

2.2. Game sequence

First, the enterprise determines the output Q and the scale of bribery b to the local government, according to the principle of profit maximisation. After anticipating the enterprise's behaviour, the local government decides to what degree can the environmental regulations be relaxed X according to the principle of expected utility maximisation (Figure 1).

Specifically, the enterprise is faced with the following optimisation decisions.

$$\begin{cases} \dfrac{\partial \pi}{\partial Q} = 0 \\ \dfrac{\partial \pi}{\partial b} = 0 \end{cases} \tag{1}$$

Since this model assumes no fixed production costs, the enterprise will choose to organise production if $1\text{-}c\text{-}b\text{-}a \geq 0$. The model further assumes that the enterprise's output meets the market demand Q_{market} in this region to ensure that the local market clears off.

Under these assumptions, if aX exceeds the cost of bribery bQ, the enterprise chooses to bribe the local government, and its investment in environmental protection is $EI = a(Q\text{-}X)$.

After considering the actions of the enterprise, the local government decides on the degree of relaxation of environmental regulations X according to the principle of expected utility maximisation.

$$\frac{\partial E(U_{govern})}{\partial X} = 0 \tag{2}$$

Then the local government's optimal degree of relaxation of environmental regulations is:

$$X^* = \frac{(b+\lambda)Q}{2\alpha(1-\lambda)(1-\gamma)} + \frac{1}{2p_0\alpha} + \frac{Q}{2} \tag{3}$$

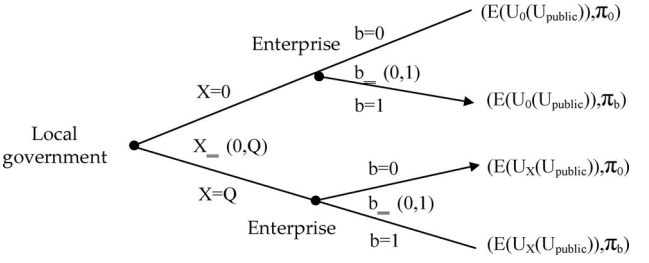

Figure 1. A game sequence model illustrates the relationship between the interests and behaviours of three subjects: the government, the public, and the enterprise. *Source:* Drawn by authors.

Substitute X^* into the profit function of the enterprise, and then:

$$\pi = Q - cQ - bQ - \alpha Q + \alpha\left[\frac{(b+\lambda)Q}{2\alpha(1-\lambda)(1-\gamma)} + \frac{1}{2p_0} + \frac{Q}{2}\right] \tag{4}$$

If aX^*-$bQ > 0$, that is $2(1-\lambda)(1-\gamma)<1$, the enterprise chooses to bribe the local government. In this case $\frac{\partial\pi}{\partial b} > 0$, which means that the higher the proportion of bribery, the greater the profitability. Since our paper assumes that $b \leq 1$-c-a, the enterprise chooses the optimal bribery ratio as $b = 1$-c-a, the enterprise's investment in environmental protection equals $EI_b^* = \frac{\alpha}{2}Q - \frac{1}{2p_0} - \frac{(1-c-\alpha+\lambda)Q}{2(1-\lambda)(1-\gamma)}$. When aX^*-$bQ \leq 0$, the enterprise will not choose to bribe the local government, then $EI_{un}^* = \alpha Q$.

2.3. Results and hypothesis

This model assumes that $Q{=}Q_{market}$. Q_{market} is exogenous and does not change under the influence of the local government's attention to public happiness 1-λ, the public attention to the environment 1-γ, the enterprise's investment in environmental protection EI, or the enterprise's bribery of the government b.

Therefore, according to this model, the results of the optimisation decision of the corporate EPI are as follows:

If $2(1-\lambda)(1-\gamma)<1$, the enterprise bribes the local government $b = 1$-c-a, then $EI_b^* = \frac{\alpha}{2}Q_{market} - \frac{1}{2p_0} - \frac{(1-c-\alpha+\lambda)Q_{market}}{2(1-\lambda)(1-\gamma)}$. If $2(1-\lambda)(1-\gamma)\geq 1$, the enterprise does not bribe the local government, then $EI_{un}^* = \alpha Q_{market}$.

According to the above results of the optimisation decision, when the local government loosens the environmental regulations, the corporate EPI decreases in such cases $EI_{un}^* > EI_b^*$. Therefore, we propose hypotheses as follows.

H1: Environmental regulations issued by the government can motivate enterprises to increase investment in environmental protection.

H2: Government intervention does not encourage enterprises to increase investment in environmental protection.

Even if enterprises bribe the government and get it to relax environmental regulations, the optimal level of EPI will still be affected by public objections and demands. $\frac{\partial EI_b^*}{\partial(1-\gamma)} > 0$ Indicates that corporate EPI will increase with the increase of public participation in environmental matters. In this regard, this paper proposes a hypothesis as follows.

H3: Public participation can motivate corporate to increase EPI.

$\frac{\partial EI_b^*}{\partial(1-\lambda)} > 0$ indicates that when local governments pay more attention to the public happiness, the optimal level of EPI increases from the view of enterprises. The higher the weight of public environmental satisfaction in the government performance assessment, the more the corporate will invest in environmental protection. The threshold value for enterprises to choose bribery is $2(1-\lambda)(1-\gamma)$, which is related to the local government's attention to public happiness $(1-\lambda)$ and public participation in environmental governance $(1-\gamma)$. With the inclusion of public happiness in local

government performance assessment and the higher significance of public participation in environmental governance, the optimal action of enterprises will be not to bribe. Thus, synergizing the government's environmental policy and public participation improves corporate EPI. In this regard, the following hypothesis is developed.

H4: The government's environmental policy and public participation can play a joint role in environmental governance.

$\frac{\partial EI_b^*}{\partial p_0} > 0$ indicates that the higher p_0 is, the more enterprises increase their EPI. The regional legal environment and the development of intermediary organisations mentioned in Chapter 2 are closely connected to the regional marketisation level in the institutional dimension. Based on this, we propose the following hypothesis.

H5: The increase in marketisation level accelerates the positive incentive effect of the government's environmental policy and public participation in the corporate EPI.

The logical relationship of the research hypotheses proposed in this paper is shown in Figure 2.

3. Empirical design

3.1. Model

To test hypotheses H1-H3, we construct the following model (5). The model X_{it} represents the core independent variables, including the government's environmental regulations, government intervention, effective public participation, and actual public participation. $Control_{it}$ is the set of control variables at the enterprise and regional levels. The specific variable definitions $Control_{it}$ are shown in Table 1.

$$EI_{it} = \alpha_0 + \sum_n \alpha_n X_{it} + \sum_k \alpha_k Control_{it} + \sum_p \alpha_p industry_p + \sum_t \alpha_t year_t + \sum_m \alpha_m state_m + \varepsilon_{it} \quad (5)$$

In order to test hypothesis H4, that is to test the effectiveness of the collaborative governance mechanisms of the government and the public, and this paper introduces the cross-multiplication term of the two variables. It constructs the following model (6).

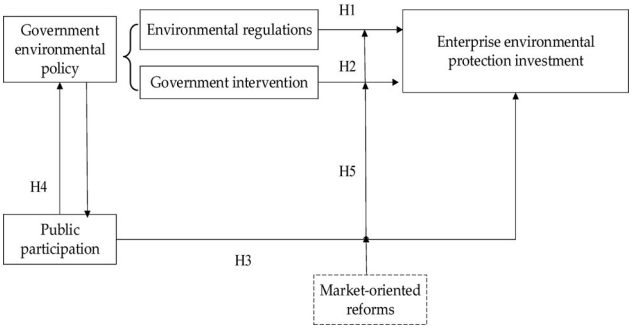

Figure 2. Logical diagram of the research hypothesis. *Source:* Drawn by authors.

Table 1. Variable definitions.

Variable symbol	Variable name	Variable measurement method
EI	Enterprise's environmental protection investment	Enterprise's increased investment in environmental protection /total assets
regulation	Government's environmental regulation	Local government's income coming from the pollution charges/added value of secondary industry
intervention	Government intervention	Local government non-tax revenue/GDP
el	Effective public participation 1	Total number of environmental letters by region
ep	Effective public participation 2	Total number of environmental petition batches in each region
baidu	Actual public participation 1	The reciprocal of the number of searches of the 'environmental pollution' keyword on Baidu in 2014
attention	Actual public participation 2	Local environmental emergencies × Proportion of internet users (local/countrywide)
current	Flow ratio	Current assets/current liabilities of the enterprise
roe	Return on assets	(Total profit + financial expenses)/total assets
Z	Governance structure Z index	The ratio of the shareholding of the company's largest shareholder to the second-largest shareholder
fdi	Intensity of foreign investment	Regional FDI/GDP
sir	Proportion of secondary industry	Regional secondary industry output/regional GDP

Source: Listed by authors.

$$EI_{it} = \beta_0 + \sum_a \beta_a Government_{it} + \sum_b \beta_b Public_{it} + \beta_c Government_{it} * Public_{it} + \sum_k \beta_k Control_{it} + \sum_p \beta_p industry_p + \sum_t \beta_t year_t + \sum_m \beta_m state_m + \varepsilon_{it} \quad (6)$$

Model (6) $Government_{it}$ represents the government's policy, including the government's environmental regulations and government intervention. $Public_{it}$ represents public participation, including effective public participation and actual public participation. The cross term $Government_{it} \times Public_{it}$ represents the impact of the collaborative influence of the two variables on corporate EPI. β_c is the key coefficient that will be incorporated in order to test whether hypothesis H4 is true.

3.2. Variables

3.2.1. Dependent variable

Eyraud et al. (2013) refer to green investment as an investment necessary to reduce greenhouse gas and air pollutant emissions without significantly reducing the production and consumption of non-energy goods. Furthermore, the term green investment can cover both public and private investment. In this paper, the total expenditure on green investment is reduced to the expenditures of enterprises. The enterprise's new environmental protection expenditures ratio to the average total assets is set as a dependent variable.

3.2.2. Core independent variables

This paper describes the government's policy in two aspects: government regulations and government intervention. To examine the government's policy related to environmental regulations, some studies have constructed variables based on the environmental regulation policy system and the intensity of pollution charges collection (Cole & Elliott, 2007; Gray et al., 2014). Regarding the EPI in China, it is hard to quantify the data on environmental regulations effectively. The reason is that at the governmental level, the relationship between formulating and implementing environmental laws and regulations is complex, and there are significant differences in the enforcement of the regulations at all government levels. As of 2022, the construction of the pollution charge system in China is relatively mature. Therefore, through studying the intensity of pollution charges collection, it can effectively examine the government's policy concerning environmental regulations. In this study, the added value of the secondary industry in each region was used to standardise the income earned through the collection of pollution charges. This way, the variable of environmental regulations (*regulation*) is obtained. Furthermore, the extent of government intervention (*intervention*) is measured by the non-tax revenue of each local government.

Public participation is another core independent variable in this model. Existing studies mainly constructed variables of public participation in environmental protection based on the available information on environmental protection petitions and letters. Dasgupta and Wheeler (1997), Dong et al. (2011), and Li et al. (2021) use the total number of complaint letters related to environmental pollution. Du et al. (2019) use data on the environmental protection information search on the internet to construct the public participation variable for environmental governance. Drawing on the above ideas, this paper illustrates effective public participation with the total number of letters (*el*) and petitions (*ep*) concerning environmental protection. The petitions refer to the petitioning system (xìnfǎng, 信访) in the P.R. China. It includes multiple ways for the citizens to express their concerns and demands to the government, some of them being e-mail and phone communication, as well as personal visits. Moreover, the Baidu Index (*baidu*), which uses the keyword 'environmental pollution' searched by internet users to represent public concerns about environmental pollution in each region, measures the actual public participation in environmental protection in each region. Han et al. (2016) believe that public participation in environmental governance emerged from the public attention to sudden environmental pollution events. Therefore, the environmental pollution attention index (*attention*) is constructed by multiplying the number of environmental pollution incidents in each region by the proportion of netizens in the region compared to the whole country.

3.2.3. Control variables

The fixed assets investment model states that individual factors can affect the enterprise's EPI. Referring to existing studies (Borghesi et al., 2014; Flammer, 2015; Hong et al., 2016; McGuinness et al., 2017; Khan et al., 2021), we introduce enterprise liquidity ratio (*current*), return on assets (*roe*), and z-index of governance structure (*z*) as the main influencing factors of corporate investment decisions. Furthermore, enterprises' decision-making is influenced by the regional economic environment. Following the research of Wahab

et al. (2021) and Zhu et al. (2019), this paper introduces regional FDI intensity (*fdi*) and the proportion of secondary industry (*sir*) as control variables at the regional level. The variable definitions and descriptive statistics are shown in Tables 1 and 2.

3.3. Samples and data

Due to data availability limitations, Chinese A-share listed companies from 2008 to 2014 are the subject of this research. In total, 795 companies were retained after excluding ST companies,[1] companies with incomplete data, and companies in the financial industry.

The data on the environmental protection expenditure of enterprises comes from the social responsibility reports of listed companies. The Baidu index comes from *the baidu.com* website query statistics and the data on other variables from *China Environmental Statistics Yearbook* and *China Stock Market and Accounting Research Database (CSMAR)*. To reduce the influence of extreme values on the research accuracy, 0.05% of the most extreme values on both sides were winsorised.

4. Empirical results and analysis

4.1. Baseline regression

To test hypotheses H1-H3, the possible impact of the government's environmental policy and public participation on corporate EPI, the models (5) and (6) were estimated. The empirical test results are reported in Table 3.

Column (1) in Table 3 shows that environmental regulations can significantly encourage enterprises to increase EPI, but government intervention has a negative impact on EPI. The empirical results also confirmed the detrimental impact of government intervention on corporate EPI (Lan et al., 2021). The reason is that the central government is keen to improve the regional environment, but local governments have their own interests, which leads to the relaxation of environmental regulations. With the increase in government intervention, the regulation relaxation scale increases, discouraging EPI. Some existing studies report similar conclusions. For example, Zhou (2009) reveals that under the dual-task agent framework, short-term interest-oriented government behaviour cannot reduce the environmental pollution of enterprises. The experimental research of Cui and Liu (2010) shows that tax competition between local governments has a destructive effect on environmental governance. Furthermore, the

Table 2. Descriptive statistics of variables.

Variable	Number	Mean	Sd	Max	Min
EI	795	0.0082278	0.0136495	0.0527195	0.0000305
Regulation	795	6.177464	4.187829	17.7261	0.8311839
Intervention	795	−4.629811	2.477055	0.08	−8.66
EI	795	0.0458475	0.0404635	0.1480223	0.0034365
Baidu	795	0.2992814	0.2455316	1	0.0322581
Current	795	1.395169	0.8524924	3.764233	0.234837
Roe	795	0.059229	0.0392279	0.144709	−0.001987
Z	795	14.86343	18.88032	70.6959	1.0272
Fdi	795	6.530653	5.002296	20.50212	1.484469
Sir	795	0.456364	0.0991392	0.5597324	0.2167871

Source: Listed by authors.

Table 3. Results of baseline regression.

	(1)		(2)		(3)		(4)	
EI	fe	re	fe	re	fe	re	fe	fe
regulation	0.000887***	0.000603***					0.000913***	0.000974***
	(3.58)	(3.67)					(3.71)	(3.86)
intervention	−0.00112***	−0.000479*					−0.00114***	−0.000893**
	(−2.72)	(−1.68)					(−2.80)	(−2.07)
el			0.00524***	0.00638***			0.00556***	
			(2.68)	(3.87)			(2.9)	
baidu					0.000271**	0.0000187		0.000183*
					(2.15)	(0.28)		(1.69)
current	0.00272***	0.00104*	0.00241***	0.000859	0.00262***	0.000955*	0.00257***	0.00273***
	(3.34)	(1.81)	(2.95)	(1.5)	(3.19)	(1.65)	(3.19)	(3.37)
roe	0.0447***	0.0310***	0.0460***	0.0337***	0.0445***	0.0321***	0.0457***	0.0448***
	(4.71)	(4.09)	(4.79)	(4.45)	(4.63)	(4.21)	(4.85)	(4.72)
z	0.0000435	0.00000681	0.0000618	0.000015	0.0000441	0.00000828	0.0000625	0.0000452
	(0.82)	(0.22)	(1.14)	(0.5)	(0.82)	(0.27)	(1.17)	(0.85)
fdi	0.000688***	0.000267*	0.000735***	0.000259**	0.000694***	0.000250**	0.000698***	0.000717***
	(2.89)	(1.83)	(−3.3)	(2.19)	(3.1)	(2.06)	(2.95)	(3.01)
sir	0.0212**	0.0109*	0.0263***	0.0160***	0.0256***	0.0171***	0.0205**	0.0190*
	(2.21)	(1.82)	(2.74)	(2.82)	(2.66)	(2.97)	(2.15)	(1.96)
_cons	−0.0236***	−0.00857	−0.0136**	−0.000654	−0.0149**	−0.00106	−0.0243***	−0.0241***
	(−3.82)	(−1.19)	(−2.37)	(−0.10)	(−2.57)	(−0.15)	(−3.96)	(−3.90)
year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
state	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
number	795	795	795	795	795	795	795	795

Note: ***, ** and * are significance level of 1%, 5% and 10% respectively. The data in '()' represents its t statistic.
Source: Listed by authors.

more intensive the government intervention, the easier the conspiracy between the government and enterprises. The empirical results above prove that direct government actions can influence corporate environmental governance in two ways. First, they can reduce market failures caused by environmental externalities. Second, they may cause economic stagnation or even recession through redundant government intervention. The results of the above research verify the research hypotheses H1 and H2.

Columns (2) and (3) in Table 3 show the impact of public participation on corporate EPI. Public participation was divided into effective public participation and actual public participation. The empirical results show that both the effective and the actual public participation significantly positively impact corporate EPI. Effective public participation has a stronger positive incentive effect on corporate EPI, which verifies hypothesis H3.

Column (4) in Table 3 demonstrates the impact of the government's environmental policy and public participation on enterprise EPI. The empirical results show that effective public participation encourages enterprises strongly to increase the EPI, but the actual public participation has only a weak positive incentive effect on the EPI. The above empirical results support the accuracy of the previous research conclusions of this paper.

In addition, variable *current* and variable *roe* are significant factors affecting corporate EPI. Improvements in solvency and profitability also motivate enterprises to invest. The improvement of governance structure is positively associated with corporate EPI insignificantly. Industrial structure sir and corporate EPI are positively correlated at the regional level. Foreign direct investment *fdi* increases corporate EPI.

4.2. Heterogeneity test

This paper tests the above empirical results for heterogeneity based on different enterprise ownership. Specifically, depending on the actual controlling shareholder of the enterprise, enterprises are divided into central government state-owned enterprises, local government state-owned enterprises, and non-state-owned enterprises (private enterprises, foreign-funded enterprises, etc.). The variable (*state)* is assigned the value of 1, 2, and 3, respectively (Duvivier & Xiong, 2013; Li et al., 2022; Yang & He, 2015). Environmental regulations issued by the government have a significant positive incentive effect on the EPI of central government state-owned and non-state-owned enterprises. In contrast, they have an insignificant effect on the EPI of local government state-owned enterprises (column (1), Table 4). Government intervention still negatively impacts the EPI of local government state-owned enterprises. In brief, strategic interactions and disputes between local governments and local government state-owned enterprises regarding environmental regulations are more likely to occur. This is the possible reason that the environmental regulations have an insignificant impact on the EPI of local government state-owned enterprises.

Columns (2) and (3) in Table 4 measure the impact of public participation on corporate EPI by ownership. The findings reveal that effective public participation significantly stimulates the EPI of central government state-owned and local government state-owned enterprises. However, the positive impact on non-state-owned enterprises is insignificant. In contrast, public participation has a positive incentive effect on central government state-owned enterprises and non-state-owned enterprises, while its

Table 4. Results based on ownership heterogeneity.

EI	(1)			(2)			(3)		
	state = 1	state = 2	state = 3	state = 1	state = 2	state = 3	state = 1	state = 2	state = 3
regulation	0.000653*	0.000128	0.00282***	0.000743**	0.000656	0.00244***	0.000726**	0.000773	0.00260***
	(1.93)	(0.25)	(5.57)	(2.25)	(1.39)	(5.11)	(2.22)	(1.52)	(5.46)
intervention	−0.000861	−0.00131*	−0.00004	−0.000786	−0.00160***	−0.00101	−0.000627	−0.00158**	−0.000382
	(−1.18)	(−1.94)	(−0.05)	(−1.25)	(−2.68)	(−1.39)	(−0.99)	(−2.56)	(−0.49)
el				0.0262***	0.00782**	0.000944			
				(2.64)	(2.35)	(0.14)			
baidu							0.000506***	0.00013	0.000278*
							(2.87)	(0.64)	(1.85)
_cons	−0.0242**	−0.0168	−0.0257**	−0.0225***	−0.0319***	−0.0141	−0.0235***	−0.0326***	−0.0107
	(−2.39)	(−1.48)	(−2.03)	(−2.68)	(−3.68)	(−1.32)	(−2.83)	(−3.70)	(−1.03)
control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
number	277	322	196	277	322	196	277	322	196

Note: ***, ** and * are significance level of 1%, 5% and 10% respectively. The data in '()' represents its t statistic.
Source: Listed by authors.

positive incentive effect on local government state-owned enterprises is insignificant. The empirical results show that, compared with central government SOEs and non-SOEs, the effectiveness of public participation significantly impacts the environmental protection investment of the local SOEs.

4.3. Robustness test

Since there is no consistent method to construct the public participation variable, the robustness test is carried out by replacing variable *el* with variable *baidu*. The effective and the actual public participation variables are set as *ep* and *attention,* respectively. Due to the fact that data on netizens in China has been available only since 2011, our sample has been restricted. The robustness test results of the fixed-effect panel model are reported in Table 5.

The regression coefficients of column (1) in Table 5 show that the increase in environmental regulations promotes corporate EPI, but government intervention inhibits it. Columns (2) and (3) test the incentive effects of effective public participation and actual public participation on corporate EPI, respectively. Columns (4) and (5) test the impact of the government's environmental policy and public participation on companies' environmental protection investments.

4.4. Endogeneity test

Due to the potential endogeneity problem in the model, the system GMM method is used to estimate the regression coefficient (Hansen, 1982). The test results show that

Table 5. Results of robustness test.

EI	(1)	(2)	(3)	(4)	(5)
regulation	0.000247**			0.000265**	0.000298**
	(2.26)			(2.43)	(2.36)
intervention	−0.0249*			−0.0245*	−0.0223
	(−1.94)			(−1.92)	(−1.33)
Ep		0.0683**		0.0733**	
		(2.09)		(2.26)	
attention			0.00126*		0.00115
			(1.8)		(1.65)
current	0.00253***	0.00264***	0.00261***	0.00262***	0.00251***
	(3.09)	(3.21)	(2.77)	(3.21)	(2.67)
Roe	0.0441***	0.0443***	0.0193	0.0433***	0.0154
	(4.6)	(4.6)	(1.04)	(4.53)	(0.83)
Z	4.72E-05	4.52E-05	−7E-06	4.85E-05	−5E-06
	(0.88)	(0.84)	(−0.12)	(0.91)	(−0.09)
Fdi	0.000575**	0.000752***	0.00187***	0.000612**	0.00161***
	(2.28)	(3.36)	(3.9)	(2.43)	(3.19)
Sir	0.0279***	0.0225**	0.00247	0.0231**	0.00286
	(2.89)	(2.28)	(0.23)	(2.35)	(0.26)
_cons	−0.0120*	−0.0147**	−0.0124**	−0.0140**	−0.00882
	(−1.89)	(−2.55)	(−2.02)	(−2.19)	(−1.17)
Year	Yes	Yes	Yes	Yes	Yes
industry	Yes	Yes	Yes	Yes	Yes
State	Yes	Yes	Yes	Yes	Yes
number	795	795	621	795	621

Note: for ***, **, and *, the significance level is set to 1%, 5%, and 10%, respectively. The data in '()' represents its t statistic.
Source: Listed by authors.

Table 6. Results of endogeneity test.

EI	(1)	(2)	(3)	(4)	(5)
L.EI	0.0213**	0.0279***	0.0936**	0.00194**	0.0317***
	(2.45)	(2.59)	(2.36)	(2.04)	(2.69)
regulation	0.000138***			0.000247***	0.000203***
	(2.57)			(2.89)	(2.89)
intervention	−0.00135***			−0.000845*	−0.00114**
	(−3.16)			(−1.72)	(−2.47)
el		0.0128***		0.0116***	
		(9.55)		(8.5)	
baidu			5.45E-05***		1.19E-05**
			(2.95)		(2.11)
_cons	−0.0202***	−0.0105**	−0.0137***	−0.0168**	−0.0188***
	(−3.15)	(−2.35)	(−2.72)	(−2.55)	(−2.88)
control	Yes	Yes	Yes	Yes	Yes
number	368	368	368	368	368
AR(1)	0.0575	0.036	0.0389	0.036	0.0519
AR(2)	0.238	0.152	0.214	0.176	0.267
Sargan test	0.209	0.2588	0.3775	0.1446	0.2071

Note: for ***, **, and * are significant levels of 1%, 5%, and 10%, respectively. The data in '()' represents its t statistic.
Source: Listed by authors.

AR (1) is significant, but AR (2) is not, indicating no second-order sequence correlation. The null hypothesis of the Sargan test is not rejected, meaning that all instrumental variables are valid. The consistency of the coefficient with the basic regression coefficient validates the previous conclusion (Table 6).

4.5. Effectiveness of the synergistic governance of the government and the public

To provide empirical evidence, we perform an empirical test on model (2) to explore the effectiveness of collaborative governance of the government and the public. The regression results are shown in Table 7. The regression coefficients in columns (2)–(4) indicate that the government's policy has no impact on the environmental governance effectiveness of effective public participation. The regression coefficients in columns (5)–(8) reveal that environmental regulations improve the environmental governance efficiency of actual public participation. It is evident that the government's policy and public participation have a synergistic governance effect and support the views of Liao and Shi (2018). EPI increases only when actual public participation and the government's environmental regulations occur. The above empirical conclusions verify hypothesis H4.

5. Further research

The miracle of China's economic growth is an outcome of gradual market-oriented reforms in various sectors of the economy. Market-oriented reforms include product and factor market reforms, and government and market reforms for allocating economic resources. With the deepening of market-oriented reforms, the government's policy is becoming increasingly standardised. The combination of the government's regulations and supportive incentives for the enterprises embodies the ability of national governance. The efficiency of the impact of public participation in environmental governance depends not only on the increasingly standardised government policy but also on the marketisation level of the economic system itself.

Table 7. Test results of the effectiveness of collaborative governance.

EI	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
el	0.00524***	0.0133**	0.00188	−0.00698				
	(2.68)	(2.32)	(0.67)	(−0.48)				
baidu					0.000375***	0.000316**	0.000204	0.0000959
					(3.19)	(2.16)	(1.45)	(0.58)
regulation		0.000845***		0.000872***		0.000817***		0.000854***
		(3.44)		(3.54)		(3.02)		(3.19)
intervention			−0.00085**	−0.00097***			−0.000514	−0.000585
			(−2.30)	(−2.64)			(−1.28)	(−1.49)
regulation × el		−0.000596		0.000518				
		(−1.45)		(0.63)				
regulation × baidu						0.0000382**		0.0000427**
						(2.04)		(2.29)
intervention × el			−0.000931	−0.00156				
			(−1.61)	(−1.36)				
intervention × baidu							−0.00003*	−0.00003**
							(−1.68)	(−2.09)
_cons	−0.0136**	−0.0204***	−0.0149***	−0.0222***	−0.0152***	−0.0219***	−0.0153***	−0.0223***
	(−2.37)	(−3.40)	(−2.59)	(−3.66)	(−2.64)	(−3.56)	(−2.64)	(−3.60)
control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
state	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
number	795	795	795	795	795	795	795	795

Note: for ***, ** and * the significance levels are set as 1%, 5% and 10% respectively. The data in '()' represents its t statistic.
Source: Listed by authors.

Table 8. Impact test of marketisation level.

EI	(1)	(2)	(3)	(4)	(5)	(6)
regulation	0.000655*				0.000609*	0.000716**
	(1.96)				(1.85)	(2.2)
market × regulation	0.0000874*				0.0000855*	0.0000909*
	(1.82)				(1.81)	(1.95)
intervention		−0.00291**			−0.00336***	−0.00324***
		(−2.33)			(−2.80)	(−2.75)
market × intervention		0.000252*			0.000302**	0.000370***
		(1.69)			(2.11)	(2.6)
el			0.00528*		0.00764***	
			(1.87)		(2.76)	
market × el			0.000814*		0.000279	
			(1.7)		(0.59)	
baidu				0.000240**		0.000254**
				(2.2)		(2.4)
market × baidu				0.0000286**		0.0000324**
				(2.17)		(2.53)
control	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes
industry	Yes	Yes	Yes	Yes	Yes	Yes
state	Yes	Yes	Yes	Yes	Yes	Yes
number	795	795	795	795	795	795

Note: ***, **, and * are significance levels of 1%, 5%, and 10%, respectively. The data in '()' represents its t statistic.
Source: Listed by authors.

Based on the above theoretical model, this paper examines the impact of market-oriented reforms on the government's environmental policy and the efficiency of public participation.

Referring to the research of Fan et al. (2011), we set the marketisation level variable *market* and develop the following empirical model.

$$EI_{it} = \gamma_0 + \sum_n \gamma_n X_{it} + \sum_n \gamma_n market_{it} \times \ X_{it} + \sum_k \gamma_k Control_{it} + \sum_p \gamma_p industry_p + \sum_t \gamma_t year_t + \sum_m \gamma_m state_m + \varepsilon_{it} \tag{7}$$

The regression coefficients of columns (1), (3), and (4) in Table 8 show that the growth of the marketisation level enhances the positive influence of the government's environmental regulations and public environmental participation on corporate EPI. The results in column (2) show that the growth of the marketisation level weakens the negative impact of government intervention on corporate EPI, which verifies the hypothesis H5 proposed in this paper. The empirical findings support the view that market-oriented reforms can regulate the government's environmental policy. Furthermore, they can also reduce the possibility of rent-seeking corruption caused indirectly by government intervention. Market-oriented reforms mean consistent improvement of the quality of the market-economic and legal systems and the intermediary organisations. Therefore, with the growth of the marketisation level, the ability to reach actual enforcement of environmental demands through actual public participation is constantly getting stronger, which is improving the efficiency of public participation.

6. Conclusions and implications

6.1. Conclusions

This paper empirically examines the impact of the government's policy and public participation on corporate investment in environmental protection using theoretical modelling. The findings show that 1) Environmental regulations motivate enterprises to enhance EPI. However, government intervention is detrimental to the growth of EPI. 2) Public participation encourages enterprises to increase investment in environmental protection. 3) Government policy and public participation have a synergistic governance effect on the corporate EPI, encouraging enterprises to invest more. 4) Market-oriented reforms enhance the positive impact of government regulations and public participation on corporate EPI.

6.2. Implications

The research results show that the government should further play an active role in influencing and guiding the behaviour of enterprises and the public to realise the collaborative governance of green development. Firstly, for the government itself, the important position of environmental monitoring indicators should be highlighted in government officials' performance assessments to form effective incentives for government officials to promote green development actively. Second, in terms of enterprise behaviour, the government needs to carry out strict legal regulations on enterprise EPI to form a sound enterprise environmental protection investment system. However, the government's behaviour toward enterprises should be more standardised to reduce unnecessary intervention. Third, for public behaviour, the government should strengthen environmental protection publicity, improve public awareness of environmental protection and governance, open channels for the disclosure of environmental problems, reduce the cost of public access to environmental information, build a comprehensive government evaluation system based on public satisfaction, and improve the public's ability to participate in the supervision of enterprises and the government.

Due to the limitation of sample availability, this paper's sample period is relatively far from now. In future research, the sample scope and time will be further expanded, and a comparative analysis will be attempted.

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Notes

1. ST companies refer to stocks of listed companies in China that suffered losses for two consecutive years and were subject to special treatment.

ORCID

Ziwei Zhang http://orcid.org/0000-0003-4601-0645

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