

The Power of Public Oversight: The Effects of Environmental Agency Information Disclosure on Environmental Investment by Polluting Enterprises

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Abstract

Collusion between government and business presents a significant challenge to environmental governance, yet academic literature rarely addresses effective measures to address this key problem. This study addresses this gap by leveraging government information disclosure data from urban environmental protection agencies in China to empirically examine the impact of such disclosures on environmental investments by Chinese polluting enterprises. Our analysis reveals the positive effects of government information disclosure by enforcement agencies on environmental investments, particularly for enterprises characterized by higher degrees of government-business collusion. Unlike traditional supervision methods from higher authorities to lower ones, government information disclosure operates under public oversight, which can mitigate shortcomings in supervision scope and agency costs. Thus, the findings of this study offer valuable insights for addressing pollution governance challenges.

Keywords: Government information disclosure, Collusion, Environmental investment, Polluting enterprises.

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1. Introduction

With the development of the Chinese economy, environmental pollution has become a significant concern. Despite increasing governmental emphasis on environmental protection in China, the pace of environmental investment lags behind the rate of pollution (Chen et al., 2019; Tian et al., 2020). However, unlike in other countries worldwide, the government plays a more pivotal role in addressing environmental pollution issues in China. Specifically, the central government is responsible for formulating environmental policies, while local governments serve as the primary implementers of central environmental policies. Given that environmental governance represents a negative externality of public goods, short-term economic development objectives often conflict with environmental governance goals. Consequently, local governments, driven by considerations of local economic development, have strong incentives to relax environmental regulations and even collude with enterprises, tacitly permitting and tolerating excessive emissions by polluting enterprises (Guo & Shi, 2017; Wu et al., 2014; Xu & Li, 2015).

Although a considerable amount of literature recognizes government-business collusion as a critical issue in China's environmental governance (e.g., Wu et al., 2014; Kahn et al., 2015; Guo & Shi, 2017; Jia & Nie, 2017), there is a scarcity of academic studies proposing effective measures to address this key problem. Among the limited literature available, prior studies have suggested two approaches to solving the aforementioned issue: first, by altering incentives for government officials to discourage collusion (Zhang et al., 2019; Liang & Langbein, 2015); second, by devising external oversight mechanisms to prevent officials from colluding (Shen & Zhou, 2017). In terms of incentives, the technical and specialized nature of environmental assessment makes it challenging to quantify environmental conditions as easily as economic performance. The causality between environmental protection performance and the behavior of local government leaders is difficult to ascertain, weakening the incentive effects of the central government on local governments (Zhang et al., 2019; Zhang et al., 2023). In terms of external oversight, top-down administrative supervision faces limitations in scope and high agency costs, making it similarly ineffective.

Since 2008, China has implemented a government information disclosure system, requiring government agencies at all levels to establish government information disclosure network platforms and compile annual reports on government information disclosure under the requirements of the central government. The implementation of the government information disclosure system has engendered public oversight of government agencies, to some extent constraining government power and ensuring that government authority operates within the framework of transparency and the rule of law. The supervision generated by the government information disclosure system is "bottom-up," with a broader scope of oversight, and it can overcome the agency problems associated with environmental interviews and other "top-down" oversight methods. Therefore, given the constraint of government power by the government information disclosure system, we anticipate that this system will be conducive to reducing instances of collusion between government and business in environmental law enforcement, thereby improving

environmental protection efforts.

We take the first year reported in the annual government information disclosure reports of each city's ecological and environmental bureau as the implementation time of government information disclosure in different regions. This approach offers two advantages: firstly, although the State Council promulgated and implemented the "Regulations on Government Information Disclosure" in 2008, various regions did not enforce it simultaneously. In practice, the timing of the implementation of annual government information disclosure reports varies across regions. This provides convenience for us to use a multi-period Difference-in-Differences (DID) method to examine the impact of government information disclosure policies. Since policy implementation stems from unified requirements by the State Council, the different timings of government information disclosure implementation in various regions will be regarded as an exogenous shock. Secondly, previous studies on government information disclosure have mostly relied on information from the official websites of provincial-level governments, whereas this study focuses on information from the websites of city-level ecological and environmental bureaus. Environmental departments operate under a local management system (Shen & Zhou, 2017), and local environmental agencies are the primary functional departments responsible for local environmental supervision and governance, holding absolute authority and influence within the local environmental system, directly impacting production and emission practices within their jurisdiction (Hu et al., 2017). Therefore, we focus on government disclosure information on the websites of city-level ecological and environmental bureaus to establish a closer logical connection with the research topic of environmental protection.

This study utilizes data from A-share listed companies in high-pollution industries from 2008 to 2021 as research samples to empirically test the influence of city-level environmental agencies' government information disclosure on the environmental investments of these enterprises. We employ enterprise-level data instead of macro-level data such as regional pollutant emissions for two reasons: firstly, the logical focus of this study is to investigate government-business collusion relationships, and such data can only be found at the enterprise level; secondly, enterprises are the primary producers of most direct pollutants and the leading factors contributing to environmental degradation, and improvements in enterprise environmental performance form the cornerstone of macro-environmental governance (Shen & Zhou, 2017; Zhang et al., 2019). This study finds that firstly the government information disclosure by city-level environmental agencies increases environmental protection investments by high-pollution enterprises; secondly, mechanism tests reveal that for enterprises with higher degrees of government-business collusion, the governance effects of government information disclosure are more pronounced.

This study makes the following contributions: firstly, it focuses on the key issue of government-business collusion in China's environmental governance and proposes government information disclosure as a solution. This approach differs from previous "top-down" government supervision methods and overcomes the deficiencies in the scope of supervision and agency costs associated with previous

approaches. Secondly, this study enriches the literature on “government information disclosure” and provides new evidence from the perspective of environmental protection.

2. Literature Review

2.1 Key Issue in Environmental Governance in China: Government-Business Collusion

China is a politically centralized country with economic decentralization. A key indicator for assessing local officials by the central government is local economic development, which largely determines the political advancement of local officials (Chen & Li, 2005; Li & Zhou, 2005). Due to the strong externalities of environmental protection, investing in environmental protection may harm a company's economic interests, while the environmental benefits accrue to society at large. Therefore, a rational approach for companies is to seek favor from environmental enforcement agencies (Liang & Gao, 2014).

From the perspective of local governments, strict environmental law enforcement may harm local economic development, thereby reducing the probability of political advancement. Consequently, local governments have an incentive to weaken environmental law enforcement, even to shelter and tolerate the excessive emissions of polluting enterprises (Guo & Shi, 2017). Thus, a mutually beneficial situation arises between local governments and polluting enterprises. On one hand, local government officials gain greater opportunities for promotion due to local economic development, while also obtaining corrupt benefits from polluting enterprises. Additionally, local governments receive more tax benefits due to economic development. On the other hand, polluting enterprises maintain low-cost pollution operations by fostering good relationships with local government officials or even bribing them to avoid environmental penalties.

In essence, collusion between local governments and polluting enterprises forms a symbiotic relationship where both parties benefit. This dynamic creates challenges for environmental governance in China, as it undermines the effectiveness of environmental regulations and enforcement.

2.2 One Solution Approach: Altering the Incentives for Promotion of Chinese Local Officials

In the new millennium, environmental issues in China have become increasingly severe, particularly evident in the visible smog in major cities following the Beijing Olympics. This has led the Chinese government and its people to recognize the hazards of environmental pollution more profoundly. Consequently, the central government considered incorporating environmental protection factors into the promotion process of local officials. While both economic development and environmental protection are crucial factors in cadre assessment, assessing environmental protection faces several challenges in practice. Firstly, unlike economic development, establishing a clear causal relationship between environmental protection performance and the tenure of leadership cadres is difficult. Some environmental pollution is hard to observe and detect, and observed

pollution may be the result of long-term accumulation, making it challenging to directly attribute responsibility to current leaders. Secondly, there is a significant information asymmetry in environmental issues, with the technical and specialized nature of environmental assessment making it difficult to quantify environmental conditions, thereby weakening the effectiveness of the central government's vertical accountability mechanism for local governments (Shen & Zhou, 2017). Thirdly, while economic development is rewarded, environmental protection is often punished. For instance, poor environmental performance can result in a veto during the promotion process.

Despite the central government's claims to increase the weight of environmental protection in officer assessments, local government supervision of polluting enterprises has not improved in practice. For example, Zhang et al. (2019) found that in the face of increasingly stringent environmental regulations, the annual increase in environmental investment by heavily polluting industries showed a "decreasing trend" before 2012. Liang and Langbein (2015) examined the environmental consequences resulting from changes in the central performance appraisal system in 2006 (which included environmental protection factors) and found that the implementation of the new performance management system only reduced air pollutant emissions, with little effect on water and soot pollution. Zhang et al. (2019) further pointed out that the opacity and manipulability of environmental quality data weakened the role of the assessment system in enhancing the motivation of local officials for environmental governance. Faced with pressure from the central government for environmental governance, local officials may "strategically" modify environmental quality data to superficially achieve the environmental goals set by the central government.

2.3 Alternative Solution Approach: Strengthening Supervision of Local Officials

Since altering incentives has proven ineffective, can the central government's strengthening of administrative supervision of local officials be effective? Shen and Zhou (2017) found, from the perspective of environmental law enforcement supervision, that the environmental interviews introduced by the Ministry of Environmental Protection in the second half of 2014 significantly improved the environmental performance of interviewed companies. Zhang et al. (2023) examined the governance effects of central ecological and environmental protection inspections and found significant reductions in PM_{2.5} and PM₁₀ pollutant concentrations in areas with low financial incentives. While these studies discovered the positive effects of supervisory mechanisms by higher-level government departments, these supervisory methods are top-down and thus suffer from two main drawbacks: firstly, their limited scope of supervision. Constrained by the enforcement capabilities of supervisors, environmental supervision is difficult to cover all colluding local governments and polluting enterprises. Secondly, there is the issue of "who supervises the supervisors," with agency costs increasing with the level of supervision. The greater economic benefits derived from pollution, the higher the likelihood of supervisors being compromised, and the higher the intermediary agency costs.

3. Institutional Background and Hypothesis Development

On May 1, 2008, the "Regulations on Open Government Information" (hereafter referred to as the "Regulations") were implemented in China. The purpose was "to guarantee citizens, legal persons, and other organizations' lawful access to government information, enhance the transparency of government work, promote administration according to law, and fully leverage the role of government information in serving the production, life, and economic and social activities of the people." The Regulations require all levels of people's governments to establish and improve the government information disclosure system and make specific provisions on the scope, procedures, methods, and supervision and guarantee of government information disclosure. Since then, the government information disclosure system has been continuously improved: a system framework has been established, various platforms and channels for disclosure practices have been developed, and a culture of openness has been cultivated, with the concept of openness increasingly becoming a consensus in the context of government governance (Wang, 2018).

The Ecological Environment Bureau, operating under the jurisdictional management system, is the enforcer of local environmental protection policies and can directly influence production and emission methods within its jurisdiction. Various ecological environment bureaus' websites disclose local environmental protection laws and regulations, policy documents, and policy interpretations. They publish administrative enforcement procedures and penalty results. The publication of this policy and enforcement information enables polluting enterprises to have clear expectations for environmental investment decisions and provides the local community with clear supervision targets and content. The victims of environmental pollution are ordinary people in the jurisdiction, who have sufficient incentives to supervise polluting enterprises and urge environmental law enforcement departments to strictly enforce the law. This form of supervision is "bottom-up" supervision, different from the "top-down" supervision of the central government over local governments. The scope of supervision by the central government over local governments is limited and cannot be as extensive as supervision by the public. Moreover, the supervision by the central government ultimately relies on specific staff to complete, and these staff members are not exercising supervisory powers for their benefit. Therefore, their behavior faces agency issues. In contrast, supervision by the affected public resulting from government information disclosure does not suffer from agency problems and provides stronger supervisory incentives.

Additionally, a significant manifestation of government-business collusion is the tolerance of local officials towards polluting enterprises' excessive emissions, while receiving corrupt benefits from these enterprises. This puts law-abiding enterprises (those not exceeding emission standards) at a disadvantage in commercial competition. These law-abiding enterprises also have sufficient motivation to supervise polluting enterprises and the law enforcement officials colluding with them. Therefore, government information disclosure will stimulate supervision from affected or potentially affected members of the public and competitors of polluting enterprises, thus affecting the environmental protection behavior of

polluting enterprises. Based on these observations, we propose the following hypotheses:

H1: After government information disclosure, polluting enterprises' environmental protection investments will increase.

H2: Compared to non-government-business collusion enterprises, the increase in environmental investment after government information disclosure will be more significant for enterprises engaged in government-business collusion.

4. Research Design

4.1 Data Sources and Sample Selection

The data used in this study mainly include the following aspects: Firstly, government information disclosure data. This study uses the initial year of the disclosure of government information disclosure annual reports on the official websites of city-level (including prefecture-level and above) ecological environment bureaus as the time when the policy of government information disclosure was implemented in each region. Secondly, data on environmental investment by polluting enterprises. This data comes from the detailed accounts of ongoing projects in the annual reports of listed companies. Any text indicating "sewage treatment, waste gas, dust removal, energy saving," etc., in the detailed project items under construction, is considered an environmental investment. Thirdly, government-business collusion data. This study uses the proportion of business entertainment expenses (from the detailed items of management expenses) to sales revenue to express the degree of government-business collusion. Other control variable data come from the China Stock Market & Accounting Research (CSMAR) database.

The initial sample of this study consists of all A-share listed companies in pollution industries from 2010 to 2021. The determination of heavily polluting industries refers to the regulations of the Ministry of Environmental Protection in 2008.

4.2 Model and Variables

4.2.1 Model

The hypothesis proposed in this study aims to examine the impact of the phased implementation of the government information disclosure system in various regions on the environmental investment of polluting enterprises (H1). Hypothesis 2 further examines the internal mechanism of the impact of information disclosure on enterprise environmental protection behavior, namely that government information disclosure mainly targets the government-business collusion activities between local governments and polluting enterprises, thereby improving their environmental performance. Continuing the logic outlined above, this study proposes the following two models based on the above hypotheses:

$$EI_{i,t} = \beta_0 + \beta_1 Open_{i,t} + \sum Controls + \sum Firm + \sum Year + \varepsilon_{i,t} \quad (1)$$

$$EI_{i,t} = \beta_0 + \beta_1 Open_{i,t} + \beta_2 Cons_{i,t} + \beta_3 Open_{i,t} \times Cons_{i,t} + \sum Controls + \sum Firm + \sum Year + \varepsilon_{i,t} \quad (2)$$

4.2.2 Government Information Disclosure (Open)

In Model (1) and Model (2), the main explanatory variable is government information disclosure (Open). This is a dummy variable. If a city's ecological environment bureau starts publishing government information disclosure annual reports, its value is 1; otherwise, it is 0. The reason for selecting city ecological environment bureaus is that environmental protection departments operate under the jurisdictional management system and are the enforcers of local environmental protection policies, directly influencing production and emission methods within their jurisdiction. Selecting the initial year of the release of government information disclosure annual reports as the implementation year of government information disclosure policy has two reasons:

Firstly, the Regulations in 2008 explicitly stipulated the types, scope, procedures, and methods of government information disclosure. These basic requirements are must-answer questions, concentratedly reflected in government information disclosure annual reports. In other words, if there are no government information disclosure annual reports, it can be considered that the implementation according to the Regulations has not been carried out. Secondly, although the specific practices of government information disclosure vary among different cities, government information disclosure annual reports are mandatory items, with consistent content and standardized format, facilitating comparison between different cities.

It is worth noting that the initial year of government information disclosure annual reports varies among different cities. Although the Regulations in 2008 required all levels of government agencies and functional departments to disclose information in accordance with regulations, it was not initially mandatory. We compiled data on government information disclosure annual reports on the websites of city-level ecological environment bureaus and found that out of 312 cities (prefecture-level and above), 63 cities began producing and disclosing annual report information as early as 2008. The cities with the latest release of annual reports are Naqu City and Lhasa City in the Tibet Autonomous Region and Zhoukou City in Henan Province, all in 2021. Since the timing of government information disclosure varies among cities, this allows us to use the multi-period DID method. Cities that have implemented the government information disclosure system become the experimental group, while cities that have not yet implemented the system become the control group. As Model (1) and Model (2) include annual fixed effects (Year) and individual fixed effects (Firm), the time variables and individual variables in the DID model are actually hidden in the annual fixed effects and individual fixed effects. At this point, the Open variable is actually the interaction term of time variables and individual variables, and its coefficient represents the "incremental change before and after the policy compared to the control group samples," that is, the net effect of the policy.

4.2.3 Environmental Investment (EI)

Our dependent variable is the environmental investment (EI) of polluting enterprises. The reason for choosing environmental investment by polluting enterprises as the dependent variable is that due to the externalities of environmental investment, polluting industries generally do not want to invest in environmental protection. They are usually forced to invest in environmental protection under government regulation. However, if there is government-business collusion, polluting enterprises can conduct polluting production without additional investment in environmental protection. Therefore, using environmental investment as the dependent variable is consistent with the main logic of our study (government-business collusion).

Following the practices of enterprise-level environmental protection research (Zhang et al., 2019; Tang et al., 2013), this study uses expenditures related to environmental protection in the detailed accounts of ongoing projects in annual reports of listed companies as environmental investment. To control for the influence of company size, this study uses year-end total assets to normalize environmental investment. Considering that most companies (80%) do not have environmental investment projects, we also set a dummy variable EI_dum (whether environmental investment), with a value of 1 if the company has environmental projects in the detailed items of ongoing projects, and 0 otherwise.

4.2.4 Control Variables

Referring to the studies of Zhang et al. (2019) and Hu et al. (2017), this study sets the following control variables: enterprise size (Size), financial leverage (Lev), enterprise performance (ROA), state ownership status (SOE), local state ownership status (Local), enterprise growth (MTB), board size (BDsize), proportion of independent directors (OD), investment scale (Invest), investment return (ROI), foreign investment (Foreign), and CEO shareholding (Mshare). All variable names and definitions are presented in the appendix after the paper.

5. Empirical Results

5.1 Descriptive Statistics

Table 1 presents the descriptive statistics for the entire sample. From Table 1, it can be seen that: 20% of the polluting enterprises have environmental investment projects. Among these polluting enterprises with environmental investment projects, the average environmental investment amount accounts for approximately 5.6% of the year-end total assets.

83% of the companies are located in cities where government information disclosure has been implemented.

State-owned enterprises (SOEs) account for 41% of the entire sample, with local SOEs comprising 28%.

The average asset-liability ratio for all enterprises is 37%, the average return on assets (ROA) is 4%, and the average market value is 3.4 times the book value.

The average number of board members is 8.8, with independent directors accounting for 37%.

The average CEO shareholding ratio is 4%, and 45% of the companies have

overseas subsidiaries. On average, the annual increase in investment is approximately 6.9% of the total assets.

Table 1: Descriptive Statistics

Variable	N	mean	sd	p25	p50	p75
EI	7697	0.001	0.004	0	0	0
EI_dum	7697	0.204	0.403	0	0	0
Open	7697	0.831	0.375	1	1	1
Size	7697	22.34	1.323	21.41	22.15	23.13
Lev	7697	0.373	0.200	0.219	0.360	0.513
ROA	7697	0.040	0.063	0.012	0.037	0.070
SOE	7697	0.413	0.492	0	0	1
Local	7697	0.278	0.448	0	0	1
MTB	7697	3.443	3.594	1.591	2.448	3.954
BDsize	7697	8.824	1.746	8	9	9
OD	7697	0.371	0.051	0.333	0.333	0.417
ROI	7697	0.006	0.015	0	0.001	0.006
Foreign	7697	0.447	0.497	0	0	1
Mshare	7697	3.934	10.10	0	0	0.500
Invest	7697	0.069	0.069	0.023	0.051	0.093

5.2 Regression Results

Table 2 presents the impact of government information disclosure on environmental investment by polluting enterprises. The two columns in the table use the binary variable EI_dum and the continuous variable EI as dependent variables, corresponding to logit regression and OLS regression methods, respectively. In both columns, the coefficient of government information disclosure (Open) is significantly positive, indicating that government information disclosure indeed promotes the level of environmental investment by polluting enterprises. Specifically:

In column (1), the coefficient of government information disclosure (Open) is 0.035. This suggests that, compared to cities where information is not disclosed, the probability of polluting enterprises in cities where government information is disclosed engaging in environmental investment increases by 3.5%.

In column (2), the coefficient of Open is 0.0004. This implies that, compared to cities where information is not disclosed, the environmental investment by polluting enterprises in cities where government information is disclosed increases by 0.0004 (approximately 0.04% of the enterprise's year-end total assets). If calculated based on the median level of total assets, which is 4.1 billion yuan, an increase in environmental investment of 0.0004 would be approximately 1.64 million yuan. This indicates that the effect of government information disclosure on promoting environmental investment by polluting enterprises is significant.

Table 2: Impact of Government Information Disclosure on Environmental Investment by Polluting Enterprises

	(1)	(2)
	EI dum	EI
Open	0.035**	0.0004**
	(2.125)	(2.029)
Size	-0.0110	0.000
	(-1.024)	(-1.021)
Lev	-0.0610	0.000
	(-1.512)	(-0.257)
ROA	0.0340	0.00100
	(0.387)	(0.751)
SOE	0.118***	0.001**
	(2.651)	(2.163)
Local	-0.111***	-0.001*
	(-2.722)	(-1.945)
MTB	0.00100	0.000
	(0.557)	(-0.001)
BDsize	0.00700	0.000
	(1.407)	(-0.575)
OD	0.307**	0.000
	(2.320)	(-0.202)
ROI	0.314	0.00500
	(0.984)	(1.263)
Foreign	-0.00600	0.001***
	(-0.366)	(2.809)
Mshare	0	0.000
	(-0.378)	(-0.114)
Invest	-0.110	0.002**
	(-1.498)	(2.515)
Company Fixed Effects	yes	yes
Year Fixed Effects	yes	yes
Intercept	0.266	0.00400
	(1.053)	(1.227)
Sample Size	7551	7551
R ²	0.507	0.438

5.3 Mechanism Analysis

To elucidate the underlying mechanism of how government information disclosure influences environmental investment by polluting enterprises, we further examined the role of collusion between government officials and businesses. As discussed earlier, the reason why government information disclosure enhances environmental investment by polluting enterprises is that it provides the local community with clear targets and content for supervision. Meanwhile, the existence of collusion between government officials and businesses allows environmental enforcement agencies, which should be impartial, to turn a blind eye to excessive emissions from polluting enterprises. Consequently, those involved in collusion tend to cause more

severe environmental pollution within their jurisdiction, resulting in greater harm to the environmental interests of the local population. Consequently, the motivation of the public to supervise colluding enterprises is stronger, and they can more fully exert their supervisory role through channels provided by government information disclosure, such as reporting violations, providing evidence of misconduct, and applying for the disclosure of relevant results.

Moreover, compliant enterprises also have sufficient motivation to supervise collusion between government officials and businesses. Compliant enterprises may need to halt production on highly polluting production lines according to environmental regulations, make expensive investments in environmental equipment, or be fined by environmental agencies for minor emissions exceeding standards. Compared to colluding enterprises that violate emission regulations or evade fines through collusion activities, compliant enterprises have higher environmental operating costs, placing them at a competitive disadvantage. To seek fair enforcement treatment, they will also use the favorable conditions provided by government information disclosure to supervise those violating enterprises.

In Table 3, we demonstrate in the first two columns that collusion between government officials and businesses benefits polluting enterprises by reducing environmental investment². In the last two columns, we show that after the implementation of the government information disclosure system, behaviors seeking special environmental benefits through collusion have been curtailed. Following the study by Cai et al. (2011), we use the ratio of business entertainment expenses (from the detailed management expenses) to sales revenue to express the degree of collusion between government officials and businesses. In columns (1) and (2) of Table 3, the coefficient of collusion (Cons) is significantly negative, indicating that collusion behavior can bring benefits to relevant polluting enterprises (by avoiding additional environmental investment). Model (3) and (4) in the table incorporate the variable Open and its interaction term Open*Cons based on the models in columns (1) and (2). The coefficient of the interaction term represents the change in benefits brought about by collusion before and after the implementation of government information disclosure. In column (4) of Table 3, the coefficient of the interaction term is significantly positive, indicating that activities seeking benefits through collusion have been curtailed after the implementation of government information disclosure. This result confirms that the promotion of environmental investment by polluting enterprises through government information disclosure is achieved by suppressing collusion benefits.

² In China's accounting standards, the items included in business entertainment expenses are very extensive, such as travel, business trips, dining, and the purchase of corresponding gifts for clients, which are normal production and operation expenses and marketing public relations expenses. In practice, in addition to including expenses reasonable for enterprise production and operation, due to the difficulty of investigation and evidence collection and the qualitative assessment of fund expenditures, the business entertainment expense account is also widely used by enterprises to conceal corresponding expenditures for bribing government officials, maintaining government-business relations, public relations with clients and suppliers, etc. (Tian & Fan, 2018).

Table 3: Mechanism Analysis: The Role of Collusion between Government Officials and Businesses

	(1)	(2)	(3)	(3)
	EI dum	EI	EI dum	EI
Open			0.00700	0.00
			(0.323)	(0.360)
Cons	-3.967**	-0.056**	-2.200	-0.0650
	(-1.979)	(-2.305)	(-0.424)	(-1.029)
Open Cons			8.304	0.118*
			(1.452)	(1.703)
Size	0.040***	0.00	-0.0180	0.00
	(6.084)	(-0.438)	(-1.265)	(-1.045)
Lev	0.0490	0.001**	-0.0640	0.00
	(1.374)	(2.190)	(-1.383)	(-0.540)
ROA	-0.0140	0.00200	0.0670	0.00100
	(-0.139)	(1.515)	(0.644)	(0.705)
SOE	0.084***	0.001***	0.0820	0.00100
	(4.185)	(4.268)	(1.416)	(0.783)
Local	0.00900	-0.001***	-0.087*	-0.001*
	(0.459)	(-2.582)	(-1.656)	(-1.917)
MTB	-0.004**	-0.000***	0.00100	0.00
	(-2.080)	(-3.130)	(0.582)	(0.246)
BDsize	0.00200	0.00	0.00900	0.00
	(0.422)	(0.324)	(1.535)	(-0.891)
OD	0.0860	-0.00100	0.320**	0.00100
	(0.706)	(-0.656)	(1.983)	(0.374)
ROI	-0.00600	-0.00300	0.315	0.00400
	(-0.015)	(-0.551)	(0.832)	(0.833)
Foreign	-0.0160	0.000***	0.0160	0.001**
	(-1.292)	(2.760)	(0.908)	(2.526)
Mshare	-0.001**	0.00	0	0.00
	(-2.159)	(-0.097)	(0.152)	(-0.141)
Invest	-0.0290	0.003***	-0.0530	0.00200
	(-0.355)	(2.682)	(-0.630)	(1.624)
Company Fixed Effects	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes
Intercept	-0.748***	0.00200	0.385	0.00500
	(-5.035)	(0.883)	(1.230)	(1.343)
Sample Size	5786	5786	5648	5648
R ²	0.178	0.0810	0.519	0.470

5.4 Robustness Checks

5.4.1 Parallel Trends Test

One of the logical premises for the validity of the Difference-in-Differences (DID) method is that the experimental and control group samples exhibit parallel trends before the policy implementation. Following the approach of Ferrara et al. (2012) and Liu et al. (2018), the Open variable in the basic regression model is decomposed into 21 annual dummy variables, spanning from 10 years before to 11 years after the policy implementation, with the period one year before policy implementation as the base year. Figure 1 displays the results of the parallel trends test. From Figure 1, it can be observed that before policy implementation, the coefficients of the annual dummy variables are close to zero, with p-values greater than 10%. This indicates that there is no significant difference in environmental investment between the experimental group (listed companies in areas where government information disclosure has been implemented) and the control group (listed companies in areas where government information disclosure has not been implemented). However, after policy implementation, the coefficients of the annual dummy variables are mostly significantly positive and exhibit an increasing trend over time. This indicates that, relative to the control group, companies in the experimental group invest more in environmental protection. Moreover, after policy implementation, the policy effect of government information disclosure becomes increasingly evident over time.

5.4.2 Removal of Samples from Direct-Controlled Municipalities

Due to the definition of the implementation time of government information disclosure policies at the city level, which includes both prefecture-level cities and cities at or above prefecture level, municipalities such as Beijing and Shanghai, which are at the administrative level of provinces, are also considered. However, in reality, municipalities directly under central government administration, such as Beijing and Shanghai, are at a higher administrative level than other cities. These municipalities have larger urban scales, greater administrative powers, stronger resource acquisition capabilities, and more listed companies. Therefore, listed companies in directly-controlled municipalities may have different characteristics from those in non-directly-controlled municipalities, which may affect companies' environmental investment. To eliminate interference from city-level factors on the conclusions of this paper, we directly remove samples of listed companies within directly-controlled municipalities such as Beijing and Shanghai. In the first column of Table 4, when samples of companies from directly-controlled municipalities are deleted, the coefficient of Open remains significantly positive, indicating that our conclusions remain robust.

5.4.3 Replacement of Dependent Variables

Following the approach of Zhang et al. (2019), this paper conducts a robustness check by replacing the dependent variable with another proxy variable for environmental investment. Specifically, we sum the expenses for afforestation and

pollution discharge from the detailed management expenses of polluting companies, in addition to the environmental expenditure from ongoing construction projects, to represent environmental investment. After replacing the dependent variable, the coefficient of Open in the second column of Table 4 remains significantly positive, indicating the robustness of the conclusions.

5.4.4 Endogeneity Issues Arising from City Characteristics

Although government information disclosure is a mandatory requirement imposed by the central government, theoretically, it represents an exogenous shock to local governments. However, in reality, the timing of government information disclosure implementation at the city level varies. In the early stages of policy promulgation, policymakers may encourage regions with better policy foundations to lead the implementation of the policy in order to reduce resistance to policy implementation. Wang (2018) cited an evaluation report from the Peking University Public Participation Center, which found that government information disclosure policies were relatively well implemented in eastern regions and provincial capitals. In other words, the timing of city-level government information disclosure implementation may be influenced by city characteristics. To mitigate endogeneity issues arising from city characteristics, we employ the Propensity Score Matching (PSM) method. Specifically, we regress whether to disclose information (Open) as the dependent variable in a logit regression, examining the impact of factors such as city size and the process of legal systematization. Then, we obtain the propensity score for each city's Open. Subsequently, we use non-repetitive nearest neighbour matching to obtain the matched sample. These samples include cities that have already disclosed information and those that have not, but the two groups of cities are roughly comparable in terms of city size and the level of legal systematization, meaning that city characteristics do not affect the timing of government information disclosure implementation. The regression results of the matched sample after PSM are shown in the third column of Table 4. Similarly, the coefficient of Open remains significantly positive, indicating the robustness of the conclusions after controlling for endogeneity issues arising from city characteristics.

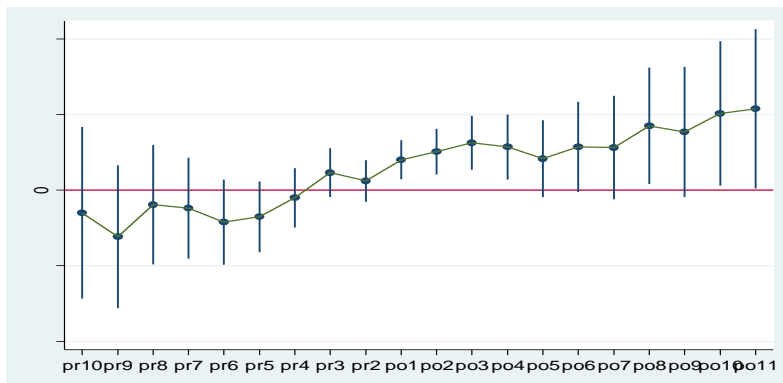


Figure 1: Parallel Trends Test

Table 4: Robustness Analysis

	Exclude Direct- Controlled Municipalities	Change Dependent Variable	PSM
	EI	hb	EI
Open	0.000* (1.702)	0.000* (1.768)	0.001** (2.066)
Size	-0.000* (-1.930)	-0.000** (-2.316)	-0.001** (-2.365)
Lev	0 (-0.586)	0 (-0.028)	0 (0.226)
ROA	0.00100 (0.875)	0.00100 (1.063)	0.003* (1.678)
SOE	0.00100 (1.173)	0.001*** (3.176)	0 (-0.195)
Local	-0.00100 (-1.614)	-0.001*** (-2.998)	0 (0.061)
MTB	0 (-0.571)	0 (0.731)	0 (-0.044)
BDsize	0 (0.279)	0 (-0.839)	0 (0.920)
OD	0.00100 (0.568)	0 (-0.132)	-0.00300 (-0.779)
ROI	0.00400 (0.803)	0.00400 (1.344)	-0.00400 (-0.499)
Foreign	0.001*** (2.706)	0.001*** (3.617)	0.001* (1.959)
Mshare	0 (-1.001)	0 (-1.267)	0 (-0.164)
Invest	0.00100 (1.323)	0.002** (2.338)	0.00100 (0.404)
Company Fixed Effects	yes	yes	yes
Year Fixed Effects	yes	yes	yes
Intercept	0.007* (1.939)	0.007** (2.572)	0.015** (2.441)
Sample Size	6058	9013	1889
F-value	1.557	3.063	1.417
R ²	0.418	0.450	0.515

6. Conclusion

Facing increasingly severe environmental challenges both domestically and internationally, the Chinese government has pledged to peak carbon emissions by 2030 and strive for carbon neutrality by 2060³. These environmental goals demonstrate the significant determination of the Chinese government in addressing environmental protection issues. However, environmental protection in China is not merely an economic or technological matter, but rather a systemic issue in administrative governance. Local governments, in pursuit of local economic development and seeking rent for local officials, often turn a blind eye or tacitly permit high-polluting enterprises to emit pollutants beyond the permitted limits, a phenomenon known as "government-business collusion," making it difficult for central government environmental policies to be effectively implemented.

While many scholars acknowledge government-business collusion as a significant issue in Chinese environmental governance, few studies have proposed effective solutions to this problem. This paper empirically examines the impact of government information disclosure on environmental investments by polluting enterprises using data on environmental information disclosure from Chinese municipal-level environmental agencies. We find that compared to polluting enterprises in cities where government information is not disclosed, those in cities where it is disclosed tend to make more environmental investments. Mechanism test results suggest that the positive impact of government information disclosure on environmental investments by polluting enterprises is primarily achieved through curbing the benefits of collusion. This evidence highlights the effectiveness of the logic route of "social public supervision—restraint of government-business collusion—improvement of local government environmental governance," thus proposing an effective approach to addressing local government environmental governance issues: government information disclosure.

To strengthen the reliability of our conclusions, we conducted several robustness tests, including parallel trend tests, changing the dependent variable, excluding samples from directly-controlled municipalities, and using propensity score matching (PSM) to alleviate endogeneity issues arising from city characteristics. After these robustness tests, our conclusions remain valid.

Compared to previous top-down supervision by the central government, such as environmental department interviews and inspections by the Central Ecological and Environmental Protection Inspectorate, the government information disclosure proposed in this paper represents a "bottom-up" approach, where social public supervision of local government environmental law enforcement is emphasized. Compared to top-down supervision, the public, as potential victims of

³ Carbon peaking refers to the point where carbon dioxide emissions cease to increase and gradually begin to decline after reaching a peak. Carbon neutrality refers to the balance between the carbon dioxide emitted directly and indirectly by human activities in a certain region over some time and the carbon dioxide absorbed through activities such as afforestation, achieving "net zero emissions" of carbon dioxide.

environmental pollution, possess stronger monitoring incentives and broader monitoring scope, providing advantages that top-down supervision lacks. China is a country with concentrated government power politically, and it is more accustomed to relying on government rather than civil forces to manage public affairs. However, the conclusions of this paper serve as a reminder to policymakers in environmental protection that disclosing government information and accepting social supervision from the general public will be an effective pathway to resolving environmental issues.

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Appendix: Variable Names and Definitions

Variable	Name	Definition
EI	Green Investment	The ratio of the total amount of environmental protection projects in construction projects to the total assets at the end of the year. If the construction project includes words such as "smoke and dust", "desulfurization", "denitrification", "solid waste treatment", "greening", "emission reduction", "energy saving", "environmental protection", it is considered as an environmental protection project.
EI_dum	Whether Green Investment	Dummy variable. If the company has environmental protection projects in the construction projects, the value is 1; otherwise, it is 0.
Open	Government Information Disclosure	Dummy variable. If the local ecological environment bureau starts to publish annual reports on government information disclosure, the value is 1; otherwise, it is 0.
Size	Enterprise Size	Natural logarithm of total assets at the end of the year.
Lev	Financial Leverage	Debt ratio, which is the total liabilities divided by total assets.
ROA	Enterprise Performance	Represents enterprise performance as net profit divided by total assets at the end of the year.
SOE	Whether State-owned Enterprise	Dummy variable. If it is a state-owned enterprise, the value is 1; otherwise, it is 0.
Local	Whether Local State-owned Enterprise	Dummy variable. If it is a local state-owned enterprise, the value is 1; otherwise, it is 0.
MTB	Enterprise Growth	Represents enterprise growth using the market-to-book ratio (market value divided by book value).
BDsize	Board Size	Number of members in the board of directors.
OD	Proportion of Independent Directors	The proportion of independent directors in the total number of directors on the board.
ROI	Investment Returns	Ratio of investment returns to total assets at the end of the period.
Foreign	Overseas Investment	Whether the company has overseas subsidiaries. If yes, the value is 1; otherwise, it is 0.
Mshare	Managerial Shareholding	Percentage of shares held by the manager.
Invest	Corporate Investment	Net increase in investment for the year, calculated as the difference between cash paid and cash received for the construction of fixed assets, intangible assets, and other long-term assets divided by total assets at the beginning of the year.