Research Article

Influencing Factors Analysis of Local Environmental Regulation Implementation Behaviors in China: Theoretical Analysis and Empirical Test

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It is a necessary means and a powerful point to promote the construction of ecological civilization by in-depth investigation of the implementation behaviors of local environmental regulation and effective identification their influencing factors. Using dynamic game method, the interaction between local government and pollution discharging enterprises is studied in the process of environmental regulation implementation, implementation behaviors and their influencing factors are analyzed, and empirically tested by Structural Equation Model. The results show that increasing marginal inspection budget and reducing marginal inspection cost can improve the inspection probability of local government; reducing the influence coefficient of enterprise profit on local government utility, increasing the weight coefficient of environmental indicators in the performance appraisal system, and increasing the administrative penalty rate, can improve the probability of levy and penalty on pollution discharging enterprises. Reducing the emission standard of pollution can increase the penalty probability; increasing pollution discharge fee rate will reduce the penalty probability on pollution discharging enterprises, while increasing the fine rate for excessive pollution will reduce the levy probability imposed on enterprises by local governments. Empirical test verifies the above theoretical analysis results. Based on the above research conclusions, it is necessary to revise incentive mechanism and restrain behavior orientation of local governments, gradually increase the environmental inspection budget, reduce the environmental inspection cost, increase rewards and punishments of environmental protection activities, reduce the influence of enterprise profit on local government utility, and scientifically formulate environmental protection standards.

1. Introduction

The implementation of environmental regulation by local governments is necessary to restrain enterprises from illegal pollution discharge, also is an important means of local governments to control pollution and improve environmental quality. How to enhance the effectiveness of environmental regulation implementation and improve environmental quality by effective measures is a common problem faced by government policy makers and researchers.

However, when it comes to a specific environmental regulatory tool, issues have not been studied, such as which factor will be affected by local regulatory behavior, how to affect, and how much the impact is. Implementation behaviors of local environmental regulation is objective and inevitable, and will show certain characteristics and laws. It is inadequate to rely solely on administrative order-style regulation, bans, accountability, and other temporary measures, which cannot effectively regulate the implementation behaviors by local governments.

We can truly understand and effectively regulate the implementation behaviors only by focusing on the specific environmental regulation tools, conducting theoretical and empirical research on the implementation behaviors and their influencing factors. What we study can help to strictly implement environmental protection policies by local
governments, construct ecological civilization and achieve harmonious economic and environmental development.

2. Literature Review

In order to solve the pollution problems, it is necessary to control or guide the behaviors of enterprises through environmental regulation, so that enterprises can directly reduce production or internalize negative external costs. Due to the interest conflict between regulatory subject and regulatory object, most of the previous studies have been carried out from the perspective of game theory.

In focusing on the behaviors of regulatory object, enterprises would inevitably adopt coping strategies under the given environmental regulation tools [1]. Even if it is voluntary environmental regulation, enterprises will still take strategic actions when they face different government-enterprise distance and policy spatial heterogeneity [2]. Most studies have concluded that government regulation is the necessary condition for emission reduction. If we want to improve the environmental quality or promote enterprise innovation, supervision and punishment must be strengthened [3–5]. However, some studies have come to a different conclusion suggesting that the measures above may be ineffective [6], or may destroy the implementation enthusiasm, which may result in ineffective environmental policies. Moreover, scholars have also studied the impact of different environmental regulatory tools on enterprises’ behaviors. For example, compared with the single environmental regulation policy of “cap and trade,” the hybrid environmental regulation policy of taxation + cap and trade plays a better role in promoting the implementation of emission reduction for enterprises [7]. Increasing the carbon tax rate and subsidies, raising the price of carbon emission rights can contribute to the diffusion of low carbon technologies among enterprises in the network [8]. Strict environmental regulation policies and monitoring mechanisms will promote enterprises’ green technology transformation to a certain extent [9].

While focusing on the behavior of the regulatory subject, most scholars have studied the environmental game between central and local governments from the perspective of Chinese actual situation, and local governments as well. Chu et al. [10] constructed a central-local-public tripartite non-cooperative game model and found that the central government could supervise the non-regulatory behaviors and motivations of local governments with administrative action. Pan et al. [11] compared the differences between central-local two-party evolutionary game model and central-local-public three party in detail, and explored the influencing factors of the strategic behaviors of each subject. Many studies have been conducted based on the perspective of competition and cooperation in terms of the behavioral interaction between local governments [12].

In addition, the influencing factors of local environmental regulation implementation behaviors have been discussed by scholars from multiple perspectives. For instance, considering information asymmetry, regional environmental preference differences and the limitation of central government resources, whether it can maximize enterprises environmental performance depends on the intensity of local environmental governance [13]. Governance subjects could choose active action strategies by improving the level of rewards and punishments to local supervision by central government, increasing the government’s governance subsidies and tax incentives to enterprises, and moderately increasing administrative fines [14]. Assessment structure, assessment intensity, reward, and punishment level are the core factors affecting environmental regulation strategies, pressure-type accountability and movement-style governance are the transmission mechanism and path through which the impact occurs [15]. Mandatory policies such as policy control, pollution control, and ecological protection can significantly reduce negative environmental effects, especially, when policy control involves explicit punishment. It is a necessary condition to achieve a high level of ecological efficiency [16].

A review of previous relevant studies shows that the study of the interaction between regulatory subjects and regulatory objects in environmental regulation based on game theory is an important perspective to solve environmental pollution problems. The research in this aspect has gradually expanded from focusing on the strategic behavior of enterprises under environmental regulation to the strategic behavior of government environmental regulation. Government environmental regulation is the premise for enterprises to take environmental protection behavior, so there is more practical significance to study the behavior of regulatory subjects for environmental policies design. However, the previous study on government environmental regulation behavior is insufficient. The description of regulatory implementation behavior, such as supervision, punishment, execution, or non-execution etc., is relatively general and unsystematic; influencing factors analysis of regulation implementation behaviors is relatively single, or mostly involves theoretical studies on costs and benefits, and there is a lack of corresponding factual evidence support. In fact, the implementation process of government environmental regulation often involves a whole set of behaviors, and each of which can be affected by different factors. Thus, a more complete and detailed theoretical analysis of government environmental regulation behavior is required, and the influencing factors should be identified.

Given the shortcomings of previous studies, this paper makes theoretical and empirical contributions to the literature. We attempt to develop a dynamic game model of environmental regulation between local governments and pollution discharging enterprises, focusing on all the behaviors in the process of local environmental regulation implementation, and carefully analyzing the various influencing factors of all the regulatory behaviors. The results of theoretical analysis were empirically tested by structural equation model (SEM), and then, the internal mechanism of improving environmental quality was explored from the perspective of local government regulation behavior. It is expected that this study could provide theoretical and empirical basis for promoting the effectiveness of environmental regulation implementation and improving the effect of environmental governance.
3. Description and Basic Model Assumptions

3.1. Description. According to the Chinese environmental protection system, the pollution discharge management is responsible for supervising and checking the pollution discharge within their jurisdiction. Local environmental protection departments are led by local governments at the same level and act in accordance with the interests of local governments to a large extent, so local governments and their constituent departments are not subdivided in the model construction, but only the game model between local governments and pollution discharging enterprises is established.

Pollution charging system involves three types of regulatory behaviors of local governments, the supervision behavior of local government on enterprises, the levy of pollutant discharge fee, and the penalty behavior of exceeding pollutant discharge respectively.

Furthermore, pollution charging system, which can be conducive to a detailed investigation of government regulation behavior, is representative and has been implemented for a long time, so this paper carries out the research based on it.

According to the Regulation on the Levy and Use of Pollution Discharge Fee and the standard management measures for the levy of pollution discharge fee, local governments will monitor and examine the actual amount of pollutant discharged by pollution discharging enterprises, and levy pollution discharge fee on the actual amount of pollutant discharged. If it is found that the actual amount of pollutant discharged is more than the allowable amount, excess discharge fine will be imposed according to the type of pollutant and the amount of excess.

In addition, local governments are responsible for allocating special funds for pollution control and subsidizing enterprises in the form of grants, etc. Taking the above factors into account, there will be different expected profits of pollution discharging enterprises and local governments under the situations of exceeding and standard emission. Table 1 shows the relevant variables and definitions from the perspective of pollution discharging enterprises and local governments.

3.2. Basic Model Assumptions from the Perspective of Pollution Discharging Enterprises. Assume that \( Q \) is the product outputs of the pollution discharging enterprises, \( \phi(Q) \) is the pollution generation function of \( Q \), which satisfies \( \partial \phi / \partial Q > 0 \), that is, the amount of pollutant increases with the increase of \( Q \). Assume that pollution control probability of pollution discharging enterprise is \( \alpha \), and the pollution reduction amount is \( f(\alpha) \), \( \partial f / \partial \alpha > 0 \), \( \partial^2 f / \partial \alpha^2 < 0 \). The generation amount of pollutant minus the reduction amount is the actual discharge amount of pollution \( E \) by the pollution discharging enterprises, i.e., \( E = \phi(Q) - f(\alpha) \) and \( \partial E / \partial \alpha = -\partial f / \partial \alpha < 0 \).

Set \( \overline{e} \) as the standard discharge amount of pollution. In the case of standard discharge, actual discharge amount will not exceed the standard discharge amount, \( E \leq \overline{e} \); then, excessive pollution discharge can be expressed as \( E > \overline{e} \). Assume that the product price is \( P(Q) \), \( \partial P / \partial Q < 0 \), the production cost is \( C_1(Q) \). Pollution control cost of the enterprise is \( C_2(\alpha) \), where \( \partial C_2 / \partial \alpha > 0 \), \( \partial^2 C_2 / \partial \alpha^2 > 0 \).

It is assumed that the supervision of pollution discharging enterprises is the premise for local governments to find out the actual pollution discharge amount. If the fee rate of pollution discharge is expressed as \( t \), then \( E \cdot t \) is the discharge fee which should be paid by the pollution discharging enterprises. When excessive there is discharge, set the fine rate by local governments as \( F_1 \), and \( (E - \overline{e}) \cdot F_1 \) is the fine for excessive discharge.

\( \theta_1 \), \( \theta_2 \), and \( \theta_3 \) describes the supervision probability \((0 \leq \theta_1 \leq 1)\), levy probability \((0 \leq \theta_2 \leq 1)\), and penalty probability \((0 \leq \theta_3 \leq 1)\) of local government regulation behavior, respectively.

\( S(\alpha) \) is the subsidy for pollution control provided by local governments to pollution discharging enterprises, the subsidy will increase with the increase of pollution control probability, i.e., \( \partial S / \partial \alpha > 0 \). According to the assumptions above, expected profits of pollution discharging enterprises \( \pi \) can be expressed in the following two scenarios.

\[
\text{Scenario 1: in case of excessive discharge:} \quad \pi = P(Q) \cdot Q + S(\alpha) - C_1(Q) - C_2(\alpha) - \theta_1 \cdot [\theta_2 \cdot E \cdot t + \theta_3 \cdot (E - \overline{e}) \cdot F_1].
\]

\[
\text{Scenario 2: in case of standard discharge:} \quad \pi = P(Q) \cdot Q + S(\alpha) - C_1(Q) - C_2(\alpha) - \theta_1 \cdot \theta_2 \cdot E \cdot t.
\]

3.3. Basic Model Assumptions from the Perspective of Local Governments. Since 1978, China has gradually transferred the power of fiscal revenue and expenditure to local governments and has gradually shifted from "fiscal responsibility system" to "tax-sharing system." Although local governments have gained some autonomy, the performance appraisal mechanism still imposes strong incentives and constraints on local governments.

Assume that environmental inspection budget of local government is \( B(\theta_1) \), and satisfies \( \partial B / \partial \theta_1 > 0 \). Assume that environmental inspection cost of local government is \( M(\theta_1) \), where \( M(\theta_1) \) is a strict convex function of \( \theta_1 \), and satisfies \( \partial M / \partial \theta_1 > 0 \). Assume that the implementation intensity of environmental regulation \( k \) is jointly determined by supervision, levy, and penalty behavior, \( k = \theta_1 \cdot \theta_2 + \theta_1 \cdot \theta_3 \). \( H(k) \) is the dereliction degree of environmental protection by local governments, \( \partial H / \partial k < 0 \), that is, dereliction degree of environmental protection will decrease with the increase of environmental regulation implementation intensity.

\( \delta_1 \) (0 < \( \delta_1 \) < 1) is the weight coefficient of environmental indicators in the performance appraisal system, then, \( \delta_1 \cdot H \) can be used to represent the political performance loss caused by environmental protection dereliction. Set \( F_2 \) as the rate of administrative penalty imposed by the central
government on local governments according to the degree of environmental negligence, and $F_2 \cdot H$ represents the penalty amount of local governments for environmental negligence. Political performance loss $\delta_1 \cdot H$ and penalty amount $F_2 \cdot H$ together constitute the environmental negligence cost of local governments $(\delta_1 + F_2) \cdot H$.

Assuming that local economic growth is derived from the production value of enterprises, $\pi$ can be used to refer to the level of local economic development. Set $\delta_2, (0 < \delta_2 < 1)$ as the influence coefficient of enterprise profits on local government utility, then, economic and political benefit of local governments that enterprise profits make is $\delta_2 \cdot \pi$, which come from tax revenue and economic development achievements et al. Based on the above assumptions, the expected revenue of local governments $U$ can be expressed as:

$$
U = B(\theta_1) + \theta_1 \cdot [\theta_2 \cdot E \cdot t + \theta_2 \cdot (E - \pi) \cdot F_1] - M(\theta_1) - S(\alpha) + \delta_2 \cdot \pi - (\delta_1 + F_2) \cdot H(k).
$$

(3)

Scenario 1: in case of excessive discharge:

$$
U = B(\theta_1) + \theta_1 \cdot [\theta_2 \cdot E \cdot t + \theta_2 \cdot (E - \pi) \cdot F_1] - M(\theta_1) - S(\alpha) + \delta_2 \cdot \pi - (\delta_1 + F_2) \cdot H(k).
$$

(4)

Scenario 2: in case of standard discharge:

$$
U = B(\theta_1) + \theta_1 \cdot [\theta_2 \cdot E \cdot t - M(\theta_1)] - S(\alpha) + \delta_2 \cdot \pi - (\delta_1 + F_2) \cdot H(k).
$$

4. Game Analysis between Local Government and Pollution Discharging Enterprises

4.1. Model Optimization and Analysis. In reality, pollution discharging enterprises often have the information advantage, while local government knows little about their pollution control intentions and probabilities. It is assumed that under the condition of information asymmetry, pollution discharging enterprises have priority to adopt strategic behaviors. Both local government and pollution discharging enterprises will constantly adjust their behavior choices with the ultimate goal of maximizing their respective benefits, so as to achieve a balanced result of behavior interaction.

In the actual process of environmental governance, the behavior strategies of most pollution discharging enterprises and local governments rarely appear extreme situations, such as complete pollution control, no pollution control at all, complete supervision, no supervision at all, and complete collection, no collection at all. This indicates that the optimal behavior strategy generally does not appear on the boundary of feasible region (corner solution) in terms of the strategy selection of both game sides. Therefore, it is assumed that the optimal strategy of both pollution discharging enterprises and local governments has internal point solution.

In the cases of excessive discharge (scenario 1) and standard discharge (scenario 2), scenario 1 covers three types of behavior: supervision, collection, and punishment of local government, while scenario 2 covers two: supervision and...
4.1.3. Model Optimization and Analysis of Local Government and Pollution Discharging Enterprises. In order to investigate the behavioral interaction between local government and pollution discharging enterprises, firstly, we fully differentiate (7) and (12), and obtain:

\[
\frac{d^2\pi}{d\alpha^2} \frac{\partial U}{\partial \theta_1} d\theta_1 + \frac{\partial^2 U}{\partial \theta_1 \partial \alpha} d\alpha = 0.
\]

where, by (6) and (9), we can obtain:

\[
\frac{d^2\pi}{d\alpha^2} \frac{\partial U}{\partial \theta_1} d\theta_1 = -\theta_1 \cdot E'_a \cdot t - \theta_1 \cdot E'_a \cdot F_1 > 0,
\]

\[
\frac{d^2 U}{\partial \theta_2 \partial \alpha} = (1 - \delta_2) \cdot \left( \theta_2 \cdot E'_a \cdot t + \theta_3 \cdot E'_a \cdot F_1 \right) < 0.
\]

According to the second-order condition of profit maximization of pollution discharging enterprises and benefits maximization of local government: \(\frac{d^2\pi}{d\alpha^2} < 0\), \(\frac{d^2 U}{d\theta_1 d\theta_1} < 0\), then, for pollution discharging enterprises, \(da/d\theta_1 = \frac{-\delta^2\pi/d\alpha^2}{\delta^2 U/d\alpha^2} > 0\); for local government, \(da/d\theta_1 = \frac{-\delta^2 U/d\alpha^2}{\delta^2 U/d\alpha^2} < 0\). The analysis results show that when \(\theta_2\) and \(\theta_3\) are constants, in spatially \((\theta_2, \alpha)\), the optimal response curve of pollution discharging enterprises \(\gamma_a\) tilts to the upper right, that is, with the increase of supervision probability of local government, pollution discharging enterprises will gradually increase pollution control probability; the optimal response curve of local government \(\gamma_\theta\) tilts down to the right, that is, local government will gradually reduce the supervision probability with the increase of pollution control probability of pollution discharging enterprises. The intersection point \(A_1(\theta'_1, \alpha'_1)\) of \(\gamma_a\) and \(\gamma_\theta\) determines the probability of supervision and pollution control. As shown in Figure 1 (left).

Secondly, we fully differentiate (7) and (13) and obtain:

\[
\frac{d^2\pi}{d\alpha^2} \frac{\partial U}{\partial \theta_2} d\theta_2 + \frac{\partial^2 U}{\partial \theta_2 \partial \alpha} d\alpha = 0.
\]

where, by (6) and (10), we can obtain:

\[
\frac{d^2\pi}{d\alpha^2} \frac{\partial U}{\partial \theta_2} d\theta_2 = \theta_1 \cdot E'_a \cdot t > 0,
\]

\[
\frac{d^2 U}{\partial \theta_2 \partial \alpha} = (1 - \delta_2) \cdot \left( \theta_1 \cdot E'_a \cdot t \right) < 0.
\]

According to the second-order condition of profit maximization of pollution discharging enterprises and benefits maximization of local government: \(\frac{d^2\pi}{d\alpha^2} < 0\), \(\frac{d^2 U}{d\alpha^2} < 0\), then, for pollution discharging enterprises, \(da/d\theta_2 = \frac{-\delta^2\pi/d\alpha^2}{\delta^2 U/d\alpha^2} > 0\); for local government, \(da/d\theta_2 = \frac{-\delta^2 U/d\alpha^2}{\delta^2 U/d\alpha^2} < 0\). The analysis results show that when \(\theta_2\) and \(\theta_3\) are constants, in spatially \((\theta_2, \alpha)\), the optimal response curve of pollution discharging enterprises \(\gamma_a\) tilts to the upper right, that is, with the increase of levy probability of local government, pollution discharging enterprises will gradually increase pollution control probability; the optimal response curve of local government \(\gamma_\theta\)
The above analysis reveals the interactive relationship between local government and pollution discharging enterprises. The intersection point \( A_3(\theta_1^*, \alpha_1^*) \) of \( \gamma_a \) and \( \gamma_b \) determines the probability of supervision and pollution control. As shown as Figure 1 (middle).

Finally, we fully differentiate (7) and (14) and obtain:

\[
\frac{\partial^2 \pi}{\partial \alpha^2} d\alpha + \frac{\partial^2 \pi}{\partial \alpha \theta_3} d\theta_3 = 0, \quad (0, 0).
\]

(19)

where, by (6) and (11), we can obtain:

\[
\gamma_a^* = (0, 0).
\]

(20)

According to the second-order condition of profits maximization of pollution discharging enterprises and benefits maximization of local government; \( \gamma_a^* (0, 0) \), then, for pollution discharging enterprises, \( \gamma_a^* \); for local government, \( d\alpha/d\theta_3 = -\partial^2 U/\partial \theta_3 \partial \alpha/\partial \theta_3 > 0 \). The analysis results show that when \( \theta_1 \) and \( \theta_2 \) are constants, in spatially \((\theta_3, \alpha)\), the optimal response curve of pollution discharging enterprises \( \gamma_a \) tilts to the upper right, that is, with the increase of penalty probability of local government, pollution discharging enterprises will gradually increase the pollution control probability; the optimal response curve of local government \( \gamma_b \) tilts down to the right, that is, local government will gradually reduce penalty probability with the increase of pollution control probability of pollution discharging enterprises. The intersection point \( A_3(\theta_1^*, \alpha_1^*) \) of \( \gamma_a \) and \( \gamma_b \) determines the probability of penalty and pollution control. As shown as Figure 1 (right).

4.2. Dynamic Analysis and Discussion of the Game Equilibrium. The above analysis reveals the interactive relationship between local government and pollution discharging enterprises, but the influence of changes in relevant factors on the game equilibrium between them cannot be deduced. The influence of single factor on the game equilibrium will be explored under the condition that other influencing factors remain unchanged.

(i) Differentiate (6) and (9) to \( B' \) and \( M' \), respectively

\[
\frac{\partial^2 \pi}{\partial \alpha \partial B} = 0,
\]

\[
\frac{\partial^2 U}{\partial \theta_1 \partial B} = 1 > 0,
\]

\[
\frac{\partial^2 \pi}{\partial \alpha \partial M} = 0,
\]

\[
\frac{\partial^2 U}{\partial \theta_1 \partial M} = -1 < 0.
\]

(21)

This suggests that the increase of \( B' \) will remain the optimal response curve of pollution discharging enterprises unchanged, and shift the optimal response curve of local government to the right. New equilibrium point \( A_1^*(\theta_1^*, \alpha_1^*) \) obtained after the shift of the response curve satisfies \( \theta_1^* > \theta_1^* \), \( \alpha_1^* > \alpha_1^* \). Therefore, the increase of marginal inspection budget will increase the probability of equilibrium inspection and pollution control.

This also suggests that the increase of \( M' \) will remain the optimal response curve of enterprises unchanged, and shift the optimal response curve of local government to the left. New equilibrium point \( A_1^*(\theta_1^*, \alpha_1^*) \) obtained after the shift of the response curve satisfies \( \theta_1^* < \theta_1^* \), \( \alpha_1^* < \alpha_1^* \). Therefore, the increase of marginal inspection cost will reduce the probability of equilibrium inspection and pollution control.

(ii) Differentiate (6) and (10) to \( F_1 \), respectively

\[
\frac{\partial^2 \pi}{\partial \alpha \partial F_1} = -\theta_1 \cdot \theta_3 \cdot E_a > 0,
\]

\[
\frac{\partial^2 U}{\partial \theta_1 \partial F_1} = 0.
\]

(22)

This suggests that the increase of \( F_1 \) will shift the optimal response curve of pollution discharging enterprises upward, and remain the optimal response curve of local government unchanged. New equilibrium point \( A_2^*(\theta_2^*, \alpha_2^*) \) obtained after the
shift of the response curve satisfies \( \theta_1^* < \theta_2^* \), \( \alpha_1^* > \alpha_2^* \). Therefore, increasing the fine rate will reduce the probability of equilibrium inspection and equilibrium pollution control.

(iii) Differentiate (6) and (10) to \( t \), respectively

\[
\frac{\partial^2 \pi}{\partial \alpha \partial t} = -\theta_1 \cdot \theta_2 \cdot E_a > 0, \tag{23}
\]
\[
\frac{\partial^2 U}{\partial \theta_2 \partial t} = (1 - \delta_2) \cdot \theta_1 \cdot E > 0.
\]

This suggests that the increase of \( t \) will shift the optimal response curve of pollution discharging enterprises upward, and shift the optimal response curve of local government to the right. New equilibrium point \( A_2'(\theta_2^*, \alpha_2^*) \) obtained after the shift of the response curve satisfies \( \theta_2^* (>, <, =) \theta_2^* \), \( \alpha_2^* > \alpha_2^* \). Therefore, increasing the pollutant discharge rate will increase the probability of equilibrium pollution control, however, the change of equilibrium levy probability depends on the slope and moving amplitude of the response curve, which may increase, decrease, or remain unchanged, shown in Figure 2.

(iv) Differentiate (6) and (10) to \( \delta_1 \) and \( F_2 \), respectively

\[
\frac{\partial^2 \pi}{\partial \alpha \partial \delta_1} = 0, \quad \frac{\partial^2 \pi}{\partial \theta_2 \partial \delta_1} = -H'_k(k) \cdot \theta_1 > 0, \tag{24}
\]
\[
\frac{\partial^2 U}{\partial \theta_2 \partial F_2} = 0, \quad \frac{\partial^2 U}{\partial \theta_2 \partial F_2} = -H'_k(k) \cdot \theta_1 > 0.
\]

This suggests that the increase of \( \delta_1 \) and \( F_2 \) will remain the optimal response curve of pollution discharging enterprises unchanged, and shift the optimal response curve of local government to the right. New equilibrium point \( A_2'(\theta_2^*, \alpha_2^*) \) obtained after the shift of the response curve satisfies \( \theta_2^* < \theta_2^* \), \( \alpha_2^* < \alpha_2^* \). Therefore, increasing weight coefficient of environmental indicators and administrative penalty rate will increase the probability of equilibrium inspection and equilibrium pollution control.

(v) Differentiate (6) and (10) to \( \delta_2 \), respectively

\[
\frac{\partial^2 \pi}{\partial \alpha \partial \delta_2} = 0, \tag{25}
\]
\[
\frac{\partial^2 U}{\partial \theta_2 \partial \delta_2} = -\theta_1 \cdot E \cdot t < 0.
\]

This suggests that the increase of \( \delta_2 \) will remain the optimal response curve of pollution discharging enterprises unchanged, and shift the optimal response curve of local government to the left. New equilibrium point \( A_2'(\theta_2^*, \alpha_2^*) \) obtained after the shift of the response curve satisfies \( \alpha_2^* > \alpha_2^* \), \( \theta_2^* < \theta_2^* \). Therefore, increasing influence coefficient of enterprise profits on local government revenue will reduce the probability of equilibrium inspection and equilibrium pollution control.

(vi) Differentiate (6) and (11) to \( F_1 \), respectively

\[
\frac{\partial^2 \pi}{\partial \alpha \partial F_1} = -\theta_1 \cdot \theta_3 \cdot E_a^* > 0, \tag{26}
\]
\[
\frac{\partial^2 U}{\partial \theta_3 \partial F_1} = (1 - \delta_2) \cdot \theta_1 \cdot (E - \varepsilon) > 0.
\]

This suggests that the increase of \( (0, 0) \) will shift the optimal response curve of pollution discharging enterprises upward, and shift the optimal response curve of local government to the right. New equilibrium point \( \alpha_2 \) obtained after the shift of the response curve satisfies \( \gamma_\theta_1, \gamma_\theta_2 \). Therefore, increasing the fine rate will improve the probability of equilibrium pollution control, however, the change of equilibrium penalty probability depends on the slope and moving amplitude of the response curve, which may increase, decrease, or remain unchanged.

(vii) Differentiate (6) and (11) to \( A_2 \), respectively

\[
\frac{\partial^2 \pi}{\partial \alpha \partial \theta_2} = -\theta_1 \cdot \theta_2 \cdot E_a^* > 0, \tag{27}
\]
\[
\frac{\partial^2 U}{\partial \theta_2 \partial \theta_2} = 0.
\]

This suggests that the increase of \( A_2 \) will shift the optimal response curve of pollution discharging enterprises upward, and remain the optimal response curve of local government unchanged. New equilibrium point \( A_2'(\theta_2^*, \alpha_2^*) \) obtained after the shift of the response curve satisfies \( \theta_2^* < \theta_2^* \), \( \alpha_2^* > \alpha_2^* \). Therefore, increasing the pollutant discharge rate will reduce equilibrium penalty probability, and increase the probability of equilibrium pollution control.

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**Figure 2:** The impact of increasing the pollutant discharge rate \( t \) to levy probability \( \theta_2 \) and pollution control probability \( \alpha \).
(viii) Differentiate (6) and (11) to $\delta_1$ and $F_2$, respectively

$$\frac{\partial^2 \pi}{\partial \delta_1 \partial F_2} = 0,$$

$$\frac{\partial^2 U}{\partial \delta_1 \partial F_2} = -H'_k(k) \cdot \theta_1 > 0,$$

$$\frac{\partial^2 \pi}{\partial \delta_2} = 0,$$

$$\frac{\partial^2 U}{\partial \delta_2} = -\theta_1 \cdot (E - \pi) \cdot (1 - \delta_1) \cdot F_1 < 0.$$

This suggests that the increase of $\delta_1$ and $F_2$ will remain the optimal response curve of pollution discharging enterprises unchanged, and shift the optimal response curve of local government to the right. New equilibrium point $A'_3(\theta'_3, \alpha'_3)$ obtained after the shift of the response curve satisfies $\theta'_3 > \theta'_1$, $\alpha'_3 > \alpha'_1$. Therefore, increasing weight coefficient of environmental indicators and administrative penalty rate will increase the probability of equilibrium penalty probability and equilibrium pollution control.

(ix) Differentiate (6) and (11) to $\delta_2$, respectively

This suggests that the increase of $\delta_2$ will remain the optimal response curve of pollution discharging enterprises unchanged, and shift the optimal response curve of local government to the left. New equilibrium point $A'_2(\theta'_2, \alpha'_2)$ obtained after the shift of the response curve satisfies $\theta'_2 < \theta'_1$, $\alpha'_2 < \alpha'_1$. Therefore, increasing the influence coefficient of enterprise profits on local government revenue will reduce the probability of equilibrium penalty and pollution control.

(x) Differentiate (6) and (11) to $\bar{\varepsilon}$, respectively

This suggests that the increase of $\bar{\varepsilon}$ will remain the optimal response curve of pollution discharging enterprises unchanged, and shift the optimal response curve of local government to the left. New equilibrium point $A'_1(\theta'_1, \alpha'_1)$ obtained after the shift of the response curve satisfies $\theta'_1 < \theta'_2$, $\alpha'_1 < \alpha'_2$. Therefore, increasing standard discharge amount of pollution will reduce the probability of equilibrium penalty and pollution control.

Dynamic analysis results of the game equilibrium above are shown in Table 2.

5. Empirical Analysis on the Influencing Factors of Local Environmental Regulation Implementation Behaviors

5.1. Variable Setting and Research Hypothesis. The influencing factors of local environmental regulation implementation behaviors have been theoretically analyzed in the previous section by the construction of the dynamic game model. The following contents will empirically test the results of the theoretical analysis. Since it is difficult to directly measure the variables involved in the theoretical analysis mentioned above, this paper attempts to test them empirically using Structural Equation Modelling (SEM).

Among them, external latent variables include:

(i) X1-environmental protection resources, i.e., environment related human, material, and financial resources represented by environmental supervision budget;

(ii) X2-environmental supervision cost, i.e., human, material, and financial resources invested in the process of environmental supervision;

(iii) X3-rewards and punishments degree of environmental protection behaviors on local governments by central government, which is determined by the weight coefficient of environmental indicators in the performance appraisal system and the administrative penalty imposed by the central government on local governments;

(iv) X4-influencing coefficient of enterprises profits on the local government utility, which is determined by the influence degree of enterprises profits on fiscal revenue and the weight coefficient of environmental indicators in the performance appraisal system.

(v) X5-environmental protection standards, which is determined by the standard pollution discharge amount, pollution discharge fee rate, fine rate on polluting enterprises for excessive discharge.

Internal latent variables is:

(i) $Y$-environmental regulation implementation behaviors (pollution charges), which is determined by environmental inspection, collection of pollution discharge fee and punishment for exceeding or violating pollution.

Based on the theoretical analysis, the hypothesis of interaction between latent variables can be put forward:

(i) $H_1$: X1 has significant positive impact on Y;

(ii) $H_2$: X2 has significant negative impact on Y;

(iii) $H_3$: X3 has significant positive impact on Y;
H4: X4 has significant negative impact on Y;
H5: X5 has significant positive (or negative) impact on Y.

5.2. Scale Design and Data Collection. Based on the theoretical analysis above and the reference of the verified scale, the final scale designed in this paper is shown in Table 3. Based on the observed variables, this paper designed questionnaires for government environmental protection departments and enterprises, respectively, and selected Likert 5-level scale as the measurement method. The questionnaire of government environmental protection department focuses on the information of environmental protection resources, environmental supervision cost, rewards and punishments degree of environmental protection behaviors on local governments by the central government, and influencing coefficient of enterprises profits on the local government utility et al. The enterprise questionnaire focuses on the information of environmental protection standards and environmental regulation implementation behaviors et al.

The research was completed from September to December 2021 in 5 major prefecture-level cities in J Province. The investigation targets are the municipal ecological environment protection departments and pollution discharging enterprises, covering the industries of steel, coal, chemical, and pharmaceutical et al. A total of 300 questionnaires were sent out to government environmental protection departments, and 288 were recovered. 300 enterprise questionnaires were collected and 273 were recovered. Eliminating invalid questionnaires and meeting the requirements of SEM analysis, 261 valid questionnaires for government environment protection department and enterprise were selected, respectively, which met the sample requirements of SEM analysis.

5.3. Reliability and Validity Test. Cronbach’s α coefficient method is the most commonly used reliability indicator in

| Parameter changes | Supervision θ₁ | Levy θ₂ | Penalty θ₃ | Pollution control α |
|-------------------|----------------|---------|------------|---------------------|
| B' ↑              |                |         |            |                     |
| M' ↑              |                |         |            |                     |
| t ↑               |                |         |            |                     |
| F₁ ↑              |                | Indefinite |            |                     |
| F₂ ↑              |                | Indefinite |            |                     |
| δ₁ ↑              |                |         |            |                     |
| δ₂ ↑              |                |         |            |                     |
| σ ↑               |                |         |            |                     |

Table 2: The influence of parameter changes on game equilibrium.

| Latent variables | Observed variables |
|------------------|--------------------|
| X1-environmental protection resources | X1a-current level of environmental protection human resource available X1b-current level of environmental protection material resource available X1c-current level of environmental protection financial resource available source: Previous theoretical analysis |
| X2-environmental supervision cost | X2a-the level of human resource required for environmental enforcement X2b-the level of material resource required for environmental enforcement X2c-the level of financial resource required for environmental enforcement source: [17] |
| X3-rewards and punishments degree of environmental protection behaviors on local governments by central government | X3a-environmental inspection frequency of central government on local governments X3b-weight coefficient of environmental indicators in the performance appraisal system X3c-the administrative penalty imposed by central government on local governments source: Previous theoretical analysis, [17] |
| X4-influencing coefficient of enterprises profits on the local government utility | X4a-influence degree of enterprises profits on fiscal revenue X4b-weight coefficient of economic indicators in the performance appraisal system source: Previous theoretical analysis |
| X5-environmental protection standards | X5a-difficulty in meeting pollution discharge standards X5b-level of pollution discharge fee rate X5c-level of fine rate on polluting enterprises for excessive discharge source: Previous theoretical analysis |
| Y-environmental regulation implementation behaviors | Yα-environmental inspection frequency Yβ-strictness collection level of pollution discharge fee Yγ-strictness reminder level of pollution discharge fee Yδ-strictness punishment level for exceeding or violating pollution source: Previous theoretical analysis, [18, 19] |

Table 3: Scale design.
social research and suitable for the reliability analysis of attitude and scales. This method can meet the following requirements: one single factor is measured; equal coefficient measures in statistical similarity; error score for the question is irrelevant. So, Cronbach’s $\alpha$ coefficient method was used for reliability test. The results are shown in Table 4. Cronbach’s $\alpha$ values for latent variables are all over 0.7, and the majority exceed 0.8, which indicate that the internal consistency of each variable is high and the survey results are reliable.

Exploratory factor analysis was used for the validity test, the results of KMO and Bartlett Sphere test are shown in Table 5. KMO values of government environmental protection department and enterprises are 0.774 and 0.719, respectively, both greater than 0.5. At the same time, significance probability of the Bartlett Sphere test is less than 0.001, so it meets the criteria of exploratory factor analysis.

The maximum variance orthogonal rotation method was used to exploratory factor analysis. Analysis results of government environmental protection department questionnaire and enterprises questionnaire are shown in Tables 6 and 7 respectively.

In Table 6, the eigen values of four factors are more than 1, which explains 77.663% of the variance variation and exceeds 50% of the minimum standard, showing both good convergence validity and good discriminant validity.

In Table 7, the eigen values of two factors are more than 1, which explains 71.397% of the variance variation and
exceeds 50% of the minimum standard, showing both good convergence validity and good discriminant validity.

5.4. SEM Construction and Analysis. AMOS21.0 was used to construct and analyze the SEM. There were 6 latent variables and 18 explicit variables used for measurement in the empirical analysis. The default path coefficient of error and residual variables is 1. Since the external latent variables are independently unrelated, their correlation coefficient is set as 0. The bidirectional arrows between external latent variables are hidden to make the model simple and clear. Final estimation results of SEM and parameter are shown in Figure 3 after model initial fitting, adjustment, and modification.
generally supported the theoretical model. CFIM and RMSE reached good levels, so the sample data fitting indexes reached acceptable levels, and the values of $Y$ have a significant negative impact on $X$ with the path coefficient $0.268$; the path coefficient values corresponding to the path coefficients are all less than 0.01, thus the significance requirements are met. As can be seen from Table 8, empirical results verify most of the conclusions from the theoretical analysis. $X_1$ has a significant positive impact on $Y$ with the path coefficient 0.161; $X_2$ has a significant negative impact on $Y$ with the path coefficient $-0.192$; $X_3$ has a significant positive impact on $Y$ with the path coefficient 0.268; $X_4$ has a significant negative impact on $Y$ with the path coefficient $-0.309$; $X_5$ has a significant negative impact on $Y$ with the path coefficient $-0.081$.

The fitting results of the model are shown in Table 9. All fitting indexes reached acceptable levels, and the values of CFI and RMR even reached good levels, so the sample data generally supported the theoretical model.

### 6. Conclusions

This paper analyzed the interaction between local government and pollution discharging enterprises during the process of local environmental regulation implementation in China, focused on the implementation behaviors and their influencing factors, and empirically tested the theoretical analysis results by using SEM.

(1) **Results of theoretical research** show that the complete environmental regulation implementation behaviors can be formed only when local governments carry out supervision, levy, and penalty on pollution discharging enterprises. The probabilities of supervision, levy, and penalty are determined by different factors.

Supervision probability of local government regulatory behavior can be improved by increasing marginal inspection budget and reducing marginal inspection cost. Penalty probability of local government regulation behavior can be improved by reducing the standard discharge of pollution. Supervision and penalty probability of local government regulatory behavior can be improved by reducing weight coefficient of environmental indicators in the performance appraisal system, increasing weight coefficient of environmental index, and increasing administrative penalty rate imposed by central government on local governments. Increasing pollution discharge fee rate will reduce penalty probability of local government to pollution discharging enterprises, but the influence on the levy probability of local government is difficult to determine. Increasing the fine rate for excessive discharge will reduce the levy probability of local government regulation behavior, but the impact on the penalty probability of local government is difficult to determine.

(2) **Results of empirical research** show that local environmental regulation implementation behaviors can be significantly promoted by environmental protection resources guarantee and the rewards and punishments of environmental protection behaviors from central governments to local governments. Furthermore, the promotion of rewards and punishments is significantly greater than that of environmental protection resource guarantee, indicating that direct incentive and restraint to local governments can change their environmental regulation behavior more effectively.

Environmental inspection cost and influence coefficient of enterprise profit on local government utility are the main factors to reduce the intensity of environmental regulation implementation. Among them, the effect of enterprise profit on local government utility, which is a hindering factor, is significantly greater than that of environmental inspection cost, indicating that compared with the input of human, material and financial resources in the process of environmental inspection, interest consistency of government and enterprises will more obviously weaken the local environmental regulation implementation behaviors.

In particular, the negative impact of environmental standards on the environmental regulations' implementation behaviors has been confirmed, which indicates that when raising environmental standards in response to environmental pollution problem, the assessment and supervision of local governments should be strengthened, in order to mitigate the adverse impact of environmental standards on implementation behaviors.
(3) Incentive mechanism should be revised and improved to constrain the behavior orientation of local governments based on the findings above. Specific suggestions include:

① Establish and improve the public finance system, gradually increase resources input, such as the budget for environmental supervision; reduce environmental inspection cost by special government subsidies and transfer payments.

② Increasing the rewards and punishments of environmental protection behaviors from central governments to local governments. Specific measures are to increase weight coefficient of environmental indicators in the performance appraisal system, strengthen environmental inspection of central government and the public, and increase administrative penalties for environmental quality deterioration within the jurisdiction of local governments.

③ Reducing the impact of enterprise profit on local government utility. Specific measures are to appropriately reduce the weight coefficient of economic indicators in the performance appraisal system, and to appropriately weaken the direct dependence of local government fiscal revenue on the economic benefits of enterprises by the reform of fiscal and tax systems.

④ Scientifically formulate environmental protection standards, and reasonably reduce pollution discharging standards. Reduce and mitigate the adverse impact of environmental protection standards improvement on local environmental regulation implementation by policy combination or auxiliary policies et al.

Data Availability

All the data were obtained from open sources or investigation.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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