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Game Theory-Based Analysis of Local Governments' Behavioral Dissimilation in the Third-Party Soil Pollution Control under Chinese-Style Fiscal Decentralization

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Abstract: The participation of a third party of the environmental service enterprise theoretically increases the level and efficiency of soil pollution control in China. However, Chinese-style fiscal decentralization may have a negative impact on the behaviors of participants, especially the local government. First, this paper conducts a positioning analysis on participants of the third-party soil pollution control in China and discusses the behavioral dissimilation of the local government under fiscal decentralization. Second, taking the government's third-party soil pollution control as a case, a two-party game model of the central government and the local government is established around the principal-agent relationship, and a tripartite game model of the central government, the local government, and the third-party enterprise is designed around the collusion between the local government and the third-party enterprise. The results show that Chinese-style fiscal decentralization may lead to the behavioral dissimilation of local governments, that is, they may choose not to implement or passively implement the third-party control, and choose to conspire with third-party enterprises. Improving the benefits from implementing the third-party control of local governments and third-party enterprises, enhancing the central government's supervision probability and capacity, and strengthening the central government's punishment for behavioral dissimilation are conducive to the implementation of the third-party soil pollution control. Finally, this study puts forward policy suggestions on dividing the administrative powers between the central and local government in third-party control, building appraisal systems for the local government's environmental protection performance, constructing environmental regulation mechanisms involving the government, market and society, and formulating the incentive and restraint policies for the participants in the third-party soil pollution control.



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1. Introduction

Ecological civilization refers to the sum of material and spiritual achievements made by human beings following the objective law of harmonious development of human, nature, and society [1,2]. Environmental pollution has become an important factor that restricts the realization of ecological civilization and sustainable development. Whether in Sustainable Development Goals (SDGs) implemented by the United Nations [3], or in the construction of ecological civilization implemented by China [4], environmental pollution control has been given more attention around the world [5,6]. Based on environmental resource elements, environmental pollution can be divided into air, water, and soil pollution. Among these pollutions, soil pollution has the characteristics of concealment, hysteresis, accumulation, nonuniformity, and irreversibility, so the process of soil pollution control is arduous [7]. Generally, the cost of soil pollution control is high, the remediation cycle is long, and the technology is complicated. With the rapid economic growth, China has faced with the situation of widespread environmental pollution [8], and soil pollution is relatively

serious in some regions [9]. According to National Soil Pollution Survey Bulletin in 2014, China's total soil exceeding standard was 16.1%, farmland exceeding standard was 19.4%, soil cadmium exceeding standard was 7.0%, heavy pollution enterprises and surrounding soil exceeding standard was 36.3%, and solid waste centralized treatment and disposal site soil exceeding standard was 21.3% [10]. The main soil problems are concentrated in the heavy metal pollution [11–14], non-point source pollution [15–18], and so on [19–21], as shown in Figure 1. It is urgent to improve the level and efficiency of soil pollution control in China.



Figure 1. Soil pollutions in China. *Note:* (a) industrial heavy metal pollution, (b) non-point source pollution of arable land, and (c) domestic waste pollution in rural areas. (Pictures sourced from <https://image.baidu.com/> and accessed on 31 December 2020.)

According to the Polluter Pays Principle, soil pollution caused by enterprises should be treated by enterprises, and pollution caused by individuals should be treated by individuals. As a public good, the ecological environment has a positive externality, and it is, thus, difficult for the market to effectively regulate [22,23]. Therefore, active intervention by the government is needed [24,25]. The traditional pollution control mode in China is that the government implements environmental regulation policies and adopts terminal control [26]. Soil pollution control has been mainly conducted by the government for a long time. The burden of the government is becoming heavier and the economic value of soil pollution control cannot be reflected [27]. By broadening environmental pollution control modes and the transforming government functions, the third-party control of environmental pollution was put forward in China on the basis of energy performance contracting (EPC) [28–30]. Similar to public-private partnerships (PPP) [31,32], the third-party control of environmental pollution is a mode in which polluters entrust environmental service enterprises to carry out pollution control by paying according to a contract [33]. In 2017, the Ministry of Environmental Protection of China issued the *Opinions on Promoting the Implementation of the Third-Party Control of Environmental Pollution*, which calls for “actively carrying out pilot demonstrations of third-party control, focusing on the prevention and control of air, water, and soil pollution” [34].

Theoretically, the third-party control of soil pollution promotes the specialization and marketization of pollution control, which can increase investment and improve the efficiency of soil pollution control. However, as a highly centralized country, the Chinese government system determines that, when implementing a policy, subordinates adopt various strategies to address it [35]. There are policies above and countermeasures below because of the different positions and motivations of participants. The third-party control of soil pollution has reduced direct government expenditure that was mainly allocated to local governments in the form of special central government funds. After the division of

authority and expenditure responsibility in the environmental field, local governments are faced with the double pressure of a shortage of funds and the great task of pollution control [36]. Under Chinese-style fiscal decentralization, the principal-agent relationship between the central government and the local government will also occur in the third-party soil pollution control. The third-party enterprise is also added as a participant, so the moral hazard problem may be more complicated due to information asymmetry. Therefore, we need to discuss the behavioral characteristics of participants in soil pollution control, construct the game model involving all participants, analyze influencing factors of behaviors, and propose suggestions to promote the third-party soil pollution control in China.

Therefore, this paper mainly answers the following questions:

- (1) What participants are involved in the third-party soil pollution control in China? What are the behavioral characteristics of all kinds of participants?
- (2) What behavioral dissimulation may be generated in the third-party soil pollution control under Chinese-style fiscal decentralization? How do these behaviors affect the level and efficiency of third-party soil pollution control?
- (3) What pivotal factors will affect the implementation of the third-party soil pollution control in China? What policies can be designed to promote the third-party control of soil pollution?

The structure of this paper is organized as follows. Section 2 reviews related studies and highlights the contributions of this paper. Section 3 introduces the participants and method used. Section 4 builds game models and gets the calculation results. Section 5 explores the research conclusions. Section 6 puts forward discussions and policy suggestions.

2. Literature Review

Existing studies mainly focus on the soil pollution control according to the types of soil pollution, such as heavy metal pollution [11–14] and agricultural non-point source pollution [15–18]. It mainly includes research on soil pollution treatment and remediation technology [37–43]. There are few studies on soil pollution control from the perspective of participants, behavioral strategies, and management modes.

Soil pollution control has gone through different stages, and the participants are enriched and the management modes are improved in the development process [44]. At the initial stage, a government-led soil pollution remediation mechanism should be established to avoid the market failure [24,45]. By transforming government functions, a diversified cooperative governance model among enterprises, nongovernmental organizations, and citizens should be established in soil pollution control, and effective supervision by the government is also needed [46,47]. Soil pollution involves a wide range of subjects, times, and regions and requires a large amount of capital [48]. It is necessary to broaden the modes of soil pollution control and improve the level and efficiency of soil pollution control. The market mechanism mode of pollution control was put forward and applied in soil pollution, such as emission trading [49] and payments for environmental services [50,51]. On the basis of drawing on the practical experience of the economic policies of soil pollution remediation and treatment in developed countries, Dong advanced ideas and priorities for the innovation of economic policies for soil pollution remediation and treatment, such as actively implementing the third-party soil pollution treatment [27]. Huang studied heavy metal pollution in a farmland's third-party control model by analyzing the characteristics and behaviors of subjects (governments, third parties, and agricultural producers) in different categories of farmland and put forward policy suggestions to improve the level of heavy metal pollution control [52]. A sustainable remediation approach must be adopted to balance the environment and nature [53].

Scholars have carried out a series of studies on fiscal competition between local governments and analyzed the impact on environmental protection in normative and empirical research. The research results are controversial. Some scholars suggest that local government competition is conducive for promoting environmental protection. The

fiscal competition among local governments is similar to market competition in that they both compete to provide effective public services to improve the welfare of residents [54]. It can improve the expenditure efficiency of local governments such as the efficiency of government environmental governance [55]. However, more scholars hold the opposite view and argue that competition between local governments causes environmental deterioration. From the perspective of intergovernmental tax competition, Oates contended that, although local governments win in attracting capital by lowering the tax rate, this leads to a low level of public expenditure [56,57]. Fiscal competition among local governments leads to the scale inefficiency of local public expenditure, which might cause the “structural inefficiency” of local government expenditure, which reduces the expenditure on public services of residents’ welfare [58]. To gain short-term economic competitive advantages among regions, local governments may relax the regulation and governance of the environment to expand the tax base and increase tax revenue [59–61].

Under the political system of fiscal decentralization in China, the relationship between the central government and local governments and the relationship between local governments determines the behaviors of governments at all levels in environmental pollution control [62]. Under the circumstances of fiscal decentralization and political centralization in China, the pressure of economic competition of local governments leads to the distortion of local public policies and the distortion of environmental protection policy, as a public policy with positive externalities, cannot be avoided [63–65]. In pursuit of economic growth, local governments often ignore the environment, even at the expense of the environment [66]. With the goal of maximizing the overall welfare of society, local governments adopt cooperative approaches to environmental pollution control [67]. Cooperation of local governments is conducive for increasing economic utility and reducing environmental utility loss [68]. Once cooperation does not exist, there will be a “prisoner’s dilemma” in environmental governance, which requires the intervention of the central government [69]. The coefficient of fiscal decentralization on the discharge of pollutants was discussed in some studies, and it turned out that fiscal decentralization aggravates environmental pollution in general [70–73]. The relationship between Chinese-style fiscal decentralization and eco-efficiency [74] as well as the spatial spillover effect of fiscal decentralization [75,76] have also been studied. The influence direction of fiscal decentralization on environmental pollution is related to the level of economic development. When the level of economic development is low, the degree of environmental pollution is negatively correlated with fiscal decentralization. When the level of economic development reaches a certain level, the degree of environmental pollution is positively correlated with fiscal decentralization [77]. Cities with low fiscal expenditure and revenue face less fiscal pressure, but environmental pollution is more serious [78]. Xin et al. discussed the impact of Chinese-style fiscal decentralization on public environmental expenditure from the two dimensions of revenue decentralization and expenditure decentralization. The results showed that there is a significant negative correlation among revenue decentralization and expenditure decentralization and public environmental expenditure [79].

As a new mode of soil pollution control, scholars currently have little or no in-depth research on the relationship of participants in third-party soil pollution control. The analysis of the impact of fiscal decentralization on environmental pollution control is mostly from the perspective of traditional pollution control modes, while the research on the impact of fiscal decentralization on third-party control is not currently available. Therefore, this paper studies the third-party soil pollution control under fiscal decentralization. All involving participants of third-party soil pollution control are redefined. Two-party game models and a tripartite game model are established to analyze the behavioral dissimulation under Chinese-style fiscal decentralization. The factors that influence the behaviors of the central government, the local government, and the third-party enterprise are discussed, and comprehensive policy suggestions are provided accordingly.

3. Material and Methodology

3.1. Participants in the Third-Party Soil Pollution Control

According to different entrusting parties, the third-party control of soil pollution mainly includes the government's third-party control, which is entrusted by the local government and the enterprise's third-party control entrusted by the polluting enterprise [80]. In this paper, the relationship among the main participants in the third-party soil pollution control in China is shown in Figure 2.

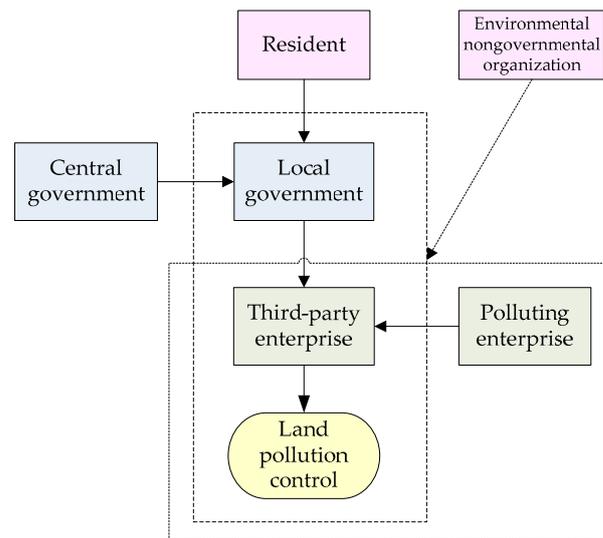


Figure 2. Participants' relationships of the third-party soil pollution control in China.

- The government's third-party soil pollution control is a mode in which the local government entrusts third-party enterprises to carry out soil pollution control. The local government is subject to the supervision of the central government as the entrusting party of pollution control. The government's third-party soil pollution control mainly includes the relationship of the central government, the local government, and the third-party enterprise.
- The enterprise's third-party soil pollution control is a mode in which the polluting enterprise entrusts the third-party enterprise to carry out soil pollution control. The polluting enterprise is subject to the supervision of the local government as the entrusting party of pollution control. The enterprise's third-party soil pollution control mainly includes the relationship of the local government, the polluting enterprise, and the third-party enterprise.

Accordingly, in the process of the third-party soil pollution control, there are three types of participants, namely, government, enterprise, and society. To maximize their own interests, these participants have different positions and behavioral strategies toward the third-party soil pollution control. Therefore, it is necessary to understand the interest demands of the participants and summarize the characteristics of their behaviors, which will serve as the basis for establishing the game model below.

(1) Participants of government

- The central government

In the third-party control of soil pollution, the central government is responsible for formulating laws and regulations on soil pollution control, coordinating interregional soil pollution control, and protection activities, supervising local governments and enterprises' soil pollution control behaviors, and preventing unknown soil pollution risks. From the perspective of more holistic and long-term interests, the central government should take into account not only economic development but also environmental costs and social welfare for the third-party control of soil pollution.

- The local government

The local governments in this paper refer to provincial governments in China. Local governments have the highest administrative responsibility in their jurisdiction for the quality of the environment. They take effective measures to improve the environmental quality and ensure that it is not affected by soil pollution and damage, including implementing the central policy, formulating and implementing a local soil protection policy in their jurisdiction, providing environment public goods and services, and monitoring the soil environment quality.

(2) Participants of enterprise

- The polluting enterprise

The behavior of polluting enterprises is highly correlated with the public property of environmental resources, the limitation of the Coase Theorem, the profit-maximization goal of enterprises, and the information asymmetry. In China, the soil pollution control of enterprises mainly focuses on the end treatment, which is to control the soil pollution and damage already formed. As an economic "rational man," enterprises make production decisions for the purpose of profit maximization. It is easy for enterprises to overuse environmental resources, which results in the excessive discharge of environmental pollutants.

- The third-party enterprise

By introducing the third-party of environmental service enterprises into the market, the polluter pays the third-party enterprises so that the third-party enterprises can control soil pollution. The direct environmental responsibility of polluters can be transferred to indirect responsibility to realize professional, large-scale, and efficient soil pollution control. There are the entrusted operation mode and the construction operation mode of third-party enterprises in China, according to the different ownership of facilities. The first one is that the third parties use the pollution control facilities of the entrusted enterprises for operation and management. The second one is that the third parties build pollution control facilities through financing and carry out pollution control. Third-party enterprises provide various environmental services, such as pollution control, environmental remediation, and environmental monitoring in accordance with the contract. Third-party enterprises not only generate economic income but also increase social welfare. As third-party enterprises provide pollution control services to polluters, it also pursues profit maximization as its goal. Therefore, a moral hazard and collusion with local governments and third-party enterprises may occur because of the principal-agent relationship.

(3) Participants of society

- The resident

Residents can best represent social welfare in soil pollution control because the quality of soil environment is closely related to personal interests, which requires every citizen to participate. Residents should actively participate in the environmental impact assessment (EIA), which not only protects their own rights and interests, but also reflects their sense of responsibility and makes up for the shortage of soil pollution control. In addition, residents should have an awareness and actions of environmental protection in their daily life. However, at present, residents' awareness of environmental protection in China is not sufficient, and the degree of participation is still low. Most people think that environmental governance has nothing to do with them, and their desire and motivation to participate in environmental governance are not strong.

- The Environmental Nongovernmental Organization (ENGO)

ENGOS are formed by the participation of growing nongovernmental forces in environmental protection. With the continuous growth of social organizations, ENGOS have developed into a social force that cannot be ignored except by the government, and they influence and supervise the behavior of enterprises. As a nonprofit organization, ENGOS

are the result of the voluntary participation of citizens, which reflects not only the public's viewpoint but also ENGOs' autonomy. The role of ENGOs is limited by administrative power. In practice, they can only reveal soil pollution by polluters, advocate stopping or reducing pollution, and appeal to the government to give more attention to pollution, but they cannot administratively or legally stop pollution behavior.

From the above analysis, it can be seen that fiscal decentralization may lead to the inconsistency of interest objectives between the central government and local governments when implementing the third-party soil pollution control. The central government promotes the third-party soil pollution control from the perspective of the overall interests of the country to maintain a balance between economic growth and environmental protection. Local governments tend to give priority to economic growth while ignoring environmental quality for short-term considerations, which results in behavioral dissimulation. The behavioral dissimulation is mainly reflected in whether the local government chooses third-party control, whether the local government colludes with third-party enterprises in the government's third-party soil pollution control, and whether the local government implements third-party control in the enterprise's third-party soil pollution control.

3.2. Mixed Strategy Game Theory

A strategy is called a pure strategy if it specifies that the participant choose only one particular action for given information. A strategy is called a mixed strategy if it requires the participant to randomly choose different actions with some probability distribution for the given information [81]. In the strategy expression of the game, the mixed strategy can be defined as the probability distribution on the pure strategy. The mixed strategy equilibrium is equivalent to the pure strategic equilibrium with incomplete information [82]. Regarding the incomplete information, this paper assumes that the game among the central government, the local government, and the third-party enterprise is the mixed strategy game.

In the strategic expression of n players' game $G = \{S_1, \dots, S_n; u_1, \dots, u_n\}$, the mixed strategy combination $\sigma^* = (\sigma_1^*, \dots, \sigma_i^*, \dots, \sigma_n^*)$ is a Nash equilibrium, if, for $i = 1, 2, \dots, n$, the following expected revenue formula holds $v_i(\sigma_i^*, \sigma_{-i}^*) \geq v_i(\sigma_i, \sigma_{-i}^*)$ [83]. There are two methods to solve for the mixed strategy equilibrium. One is the payoff maximization method, and the other is the payoff equivalence method. The payoff maximization method is to maximize the utility function of each participant. The payoff equivalence method is to make the payments of each participant's pure strategies equal, which constitutes the solution of the equations [84].

4. Results

Since soil pollution control is dominated by the government in China, to further simplify the analysis, this section takes the government's third-party soil pollution control as a case. The behavioral dissimulation of local governments in the process of the third-party soil pollution control under fiscal decentralization are analyzed, including whether local governments choose the third-party soil pollution control and whether local governments conspire with third-party enterprises in third-party control. The influencing factors of each subject's behavior are analyzed to find corresponding solutions for the following section.

4.1. Game Analysis of the Central Government and Local Governments

When the central government implements the policy of third-party soil pollution control, local governments adopt the strategy of execution or nonexecution. As for whether the local government chooses the third-party soil pollution control, the central government adopts the strategy of supervision or non-supervision. Based on the choice of the two strategies, the game model is assumed as follows.

- When the central government does not supervise and the local government executes the central government's policies, the local government gains X .

- When the local government chooses to execute the central government’s policies, the cost is C_1 .
- When the local government chooses not to execute the policies of the central government, the increased income is e .
- When the local government adopts the nonexecution strategy, if it is supervised by the central government, then it will be punished by C_p , and $C_p > C_1 + e$.
- When the local government executes the central policy, the local government gains revenue d .
- When the central government adopts the supervision strategy for the local government, the corresponding cost is C_2 .
- When the central government adopts the non-supervision strategy toward the local government, in the case of pollution accidents, the central government needs to add the later treatment cost t , and $t > C_2$.
- X, C_1, e, d , and C_2 are all greater than 0.

Based on the above assumptions, the game matrix of the central government and the local government is constructed, as shown in Table 1.

Table 1. The game matrix of the central government and the local government.

Central Government \ Local Government	Execution	Nonexecution
Supervision	$d - C_2, X - C_1$	$C_p - C_2, X + e - C_p$
Non-Supervision	$D, X - C_1$	$-t, X + e$

According to the above game matrix, if the central government adopts the supervision strategy, then the local government chooses the execution policy as the optimal strategy choice. If the central government adopts a non-supervision strategy, then local governments do not completely follow the policy. If the local government adopts an execution strategy, then the central government takes a hands-off approach. If the local government chooses not to implement the strategy, then the central government adopts a supervision strategy. The game matrix between the central government and the local government is not a zero-sum game, and the pure strategy Nash equilibrium cannot be realized.

In practice, the central government cannot fully supervise the local government. The local government may choose not to implement or passively implement the third-party control. Therefore, the game process is regarded as a mixed strategy game. In the establishment of the mixed strategy game model between the central government and the local government, the following assumptions are added.

- The central government supervises the local government with a probability of P .
- The local government executes the central policy with a probability of θ .
- P and $\theta \in [0, 1]$.

Under the given situation of P , the expected benefits of local government execution ($\theta = 1$) and non-execution ($\theta = 0$) are as follows.

$$U_a(P, 1) = (X - C_1)P + (X - C_1)(1 - P) = X - C_1 \tag{1}$$

$$U_a(P, 0) = (X + e - C_p)P + (X + e)(1 - P) = X + e - C_pP \tag{2}$$

By setting $U_a(P, 1) = U_a(P, 0)$, it can solve the Nash equilibrium $P' = \frac{C_1 + e}{C_p}$. When $P > P'$, the optimal strategy of the local government is to execute the policy. When $P = P'$, the local government gains the same income from execution and non-execution. When $P < P'$, the optimal strategy of the local government is not to execute the policy.

Similarly, under the given situation of θ , the expected benefits of the central government choosing to supervise ($P = 1$) and not to supervise ($P = 0$) are as follows.

$$U_b(\theta, 1) = (d - C_2)\theta + (C_p - C_2)(1 - \theta) = (d - C_p)\theta + C_p - C_2 \tag{3}$$

$$U_b(\theta, 0) = d\theta + (-t)(1 - \theta) = (d + t)\theta - t \quad (4)$$

By setting $U_b(\theta, 1) = U_b(\theta, 0)$, it can solve the Nash equilibrium $\theta' = 1 - \frac{C_2}{C_p + t}$. When $\theta > \theta'$, the optimal strategy of the central government is to supervise the local government. When $\theta = \theta'$, the central government gains the same income from supervision and non-supervision. When $\theta < \theta'$, the optimal strategy of the central government is not to supervise the local government.

According to the above calculation results, the mixed Nash equilibrium solution is $P' = \frac{C_1 + e}{C_p}$, and $\theta' = 1 - \frac{C_2}{C_p + t}$. This means that the central government supervises the local government with a probability of $\frac{C_1 + e}{C_p}$, and the local government executes the third-party soil pollution control with a probability of $1 - \frac{C_2}{C_p + t}$. Thus, it can be seen that the supervision probability of the central government is positively correlated with the execution cost of the local government, positively correlated with the revenue obtained when the local government does not execute policies, and negatively correlated with the punishment intensity of the central government to the local government. The probability of the local government executing policies is negatively correlated with the supervision cost of the central government, is positively correlated with the punishment intensity of the central government to the local government, and is positively correlated with the later treatment cost of the central government.

4.2. Game Analysis of the Central Government, Local Government, and Third-Party Enterprise

A result of a decentralized government is that, even if local governments implement third-party soil pollution control policies, they may also collude with third-party enterprises to cope with the central government's supervision. This subsection first constructs a two-party game model between the local government and the third-party enterprise and a two-party game model between the local government and the central government, and then extends the model to a tripartite game of the three participants according to the two-party game models.

4.2.1. Collusion Between Local Governments and Third-Party Enterprises

Under the current fiscal decentralization system, local governments and third-party enterprises conspire to defraud central government regulators to pursue their own interests. To further analyze the problem of collusion between the local government and the third-party enterprise, assumptions are made as follows.

- Collusion appears in the form of rent-seeking from local governments through third-party enterprises. The strategic profile of the third-party enterprise is rent-seeking and non-rent-seeking, while the strategic profile of the local government is acceptance and non-acceptance.
- When the central government supervises the local government, the input cost of soil pollution control by the local government according to the emission standard is M . When the third-party soil pollution control is entrusted, the cost of pollution control by the third-party enterprise according to the emission standard is N . If $M > N$, this means that there is rent-seeking space between the third-party enterprise and the local government $M - N$. The amount of rent-seeking offered by the third-party enterprise to the local government is S , and the income obtained by the local government from rent-seeking is S .
- The central government's supervision is effective. This means that the central government can find out whether there is collusion between the local government and the third-party enterprise. Once collusion occurs and is discovered, the economic penalty for the third-party enterprise is I , and the economic penalty for the local government is J .
- The third-party enterprise engages in rent-seeking behavior with the probability of p , while the local government accepts rent-seeking with the probability of q . Rent-

seeking and accepting rent-seeking go hand-in-hand with pollution control fraud. Therefore, as long as one party breaks the rules, the central government can impose economic penalties on it.

- $N, S, I,$ and J are all greater than 0. p and $q \in [0, 1]$.

The strategy profile game matrix under the collusion of the local government and the third-party enterprise is constructed, as shown in Table 2.

Table 2. The game matrix of the local government and the third-party enterprise.

Local Government	Third-Party Enterprise	Rent-Seeking (p)	Non-Rent-Seeking ($1-p$)
Acceptance (q)		$S - J, M - N - S - I$	$-J, 0$
Non-Acceptance ($1-q$)		$0, -I$	$0, 0$

By assuming that $M - N - S > I$ and $S > J$, this indicates that, even with the effective supervision of the central government, the local government and the third-party enterprise can still make profits in the case of collusion. When the third-party enterprise chooses rent-seeking, the best strategy choice of the local government is to accept rent-seeking. When the third-party enterprise chooses not to seek rent, the optimal strategy of the local government is not to accept rent-seeking. When the local government is willing to accept rent-seeking, the optimal strategy of the third-party enterprise is rent-seeking. When the local government does not accept rent-seeking intentions, the best strategy of the third-party enterprise is not to seek rent. Therefore, there are two Nash equilibriums (rent-seeking, acceptance) and (non-rent-seeking, nonacceptance).

Therefore, let us solve for a mixed Nash equilibrium. Given the third-party enterprise rent-seeking probability p , a hybrid strategy Nash equilibrium is realized when the expected income of the local government accepting rent-seeking ($q = 1$) and not accepting rent-seeking ($q = 0$) is the same. In addition, $p(S - J) + (1 - p)(-J) = 0$, and we can conclude that $p' = \frac{J}{S}$. This indicates that, under the condition of effective regulation by the central government, the third-party enterprise seeks rent from the local government at the probability of $\frac{J}{S}$. The rent-seeking probability of the third-party enterprise is positively correlated with the central government’s punishment intensity of the local government J and negatively correlated with the amount of rent-seeking obtained by the local government S .

In the same way, given that the local governments accept rent-seeking probability q , a hybrid strategy Nash equilibrium is realized when the expected income of the third-party enterprise rent-seeking ($p = 1$) and not rent-seeking ($p = 0$) is the same. In addition, $qM - N - S - I + 1 - q - I = 0$, and we can conclude that $q' = \frac{I}{M - N - S}$. This indicates that, under the condition of effective regulation by the central government, the local government accepts the rent-seeking of the third-party enterprise with the probability of $\frac{I}{M - N - S}$. The probability of the local government accepting rent-seeking is positively correlated with the penalty intensity on third-party enterprises imposed by the central government I and negatively correlated with the difference between revenue ($M - N$) and the rent-seeking amount of third-party enterprise S .

From the above analysis, it can be seen that, under the effective supervision of the central government, simply increasing the penalty does not necessarily reduce collusion unless the amount of the penalty exceeds the income from rent-seeking, which is closely related to rent-seeking space. Therefore, the central government needs to understand the pollution control costs, rent-seeking space of local governments, and third-party enterprises, and make punishment standards accordingly.

4.2.2. Game between the Central Government and Local Governments in Collusion

When the income obtained by accepting rent-seeking is higher than the income obtained by not accepting rent-seeking, local governments, to maximize their own interests, will accept rent-seeking from third-party enterprises and conspire with them to cheat the

central government, which results in the low efficiency of the third-party soil pollution control. Therefore, the central government is needed to exert supervision. To analyze the relationship between the central government and local governments separately, the following assumptions are made.

- The supervision cost of the central government is H , and the loss of the central government caused by collusion is $M - N$.
- The central government supervises the collusive behaviors of the local government and the third-party enterprise with probability r .
- H is greater than 0. $r \in [0, 1]$.

The mixed strategy game matrix of the central government and the local government is constructed, as shown in Table 3.

Table 3. The game matrix of the central government and the local government in collusion.

Central Government	Local Government	
	Acceptance (q)	Non-Acceptance (1-q)
Supervision (r)	$J - M - N - H, S - J$	$-H, 0$
Non-Supervision (1-r)	$-(M - N), S$	$0, 0$

Given the central government supervision probability p , a mixed Nash equilibrium strategy is realized when the expected income of the local government accepting rent-seeking ($q = 1$) and not accepting rent-seeking ($q = 0$) is the same. Then, $r(S - J) + (1 - r)S = 0$, and we can conclude that $r' = \frac{S}{J}$. This indicates that the central government supervises the collusion of the local government at the probability of $\frac{S}{J}$. The supervision probability of the central government is positively correlated with the rent-seeking income obtained by the local government S and negatively related to the punishment of the central government for the collusion behavior of the local government J .

In the same way, given that the local governments accept rent-seeking probability q , a mixed Nash equilibrium strategy is realized when the expected income of the central government implements the supervision strategy ($r = 1$) and the non-supervision strategy ($r = 0$) is the same. Then, $qJ - M + N - H + 1 - q - H = -q(M - N)$, and we can conclude that $q' = \frac{H}{J}$. This indicates that the local government accepts rent-seeking at the probability of $\frac{H}{J}$. The probability of the local government accepting rent-seeking is negatively correlated with the punishment of the central government on the local government J and positively related to the supervision cost of the central government H .

4.2.3. Tripartite Game of the Central Government, Local Government, and Third-Party Enterprise

Combined with the above two game model analyses, this paper introduces the central government, local government, and third-party enterprise simultaneously to analyze the decision-making of the tripartite game.

- When the local government colludes with the third-party enterprise and the central government adopts a non-supervision strategy, the profits of the central government, the local government, and the third-party enterprise are $-(M - N)$, S , and $M - N - S$, respectively.
- When the local government colludes with the third-party enterprise and the central government adopts a supervision strategy, there are two results: collusion found and collusion not found. When the central government finds out the collusion, the three profits are $I + J - (M - N) - H$, $S - J$, and $M - N - S - I$. When the central government does not find out the collusion, the three profits are $-(M - N) - H$, S , and $M - N - S$.
- When the local government and the third-party enterprise do not collude and the central government supervises them, the three profits are $-H$, 0 , and 0 . When the central government does not supervise, the three profits are recorded as 0 , 0 , and 0 .

- Assume that the probability of collusion between the local government and the third-party enterprise is t . When the central government conducts a supervision strategy, the capacity coefficient of the central government to find out the collusion is g . t and $g \in [0, 1]$.

Based on the above assumptions, this paper establishes the game matrix of the central government, the local government, and the third-party enterprise, as shown in Table 4.

Table 4. The game matrix of the central government, local government, and third-party enterprise.

Local Government Third-Party Enterprise	Central Government	Supervision (r)		Non-Acceptance (1-q)
		Found (g)	Not Found (1-g)	
Collusion (t)		$I + J - (M - N) - H$ $S - J$ $M - N - S - I$	$-(M - N) - H$ S $M - N - S$	$-(M - N)$ S $M - N - S$
Not Collusion (1-t)			$-H, 0, 0$	$0, 0, 0$

The equilibrium solution of the model is calculated according to the game matrix, as follows.

- (1) Nash equilibrium conditions for the third-party enterprise to choose whether to collude (rent-seeking).

Suppose that U_e^y is the expected return of the third-party enterprise. We can then get the following results.

$$U_e^y = rt[g(M - N - S - I) + (1 - g)(M - N - S)] + (1 - r)t(M - N - S) \quad (5)$$

By treating U_e^y to obtain the first-order partial derivative of t , we can obtain the following results.

$$\frac{\partial U_e^y}{\partial t} = r[g(M - N - S - I) + (1 - g)(M - N - S)] + (1 - r)(M - N - S) \quad (6)$$

When equilibrium is realized, $\frac{\partial U_e^y}{\partial t} = 0$, i.e., U_e^y is independent of t . When $\frac{\partial U_e^y}{\partial t} = 0$, the solution is $r' = \frac{M - N - S}{gI}$. When the supervision probability of the central government $r > r'$, the third-party enterprise chooses not to seek rent from the local government. When $r < r'$, the supervision intensity of the central government is relatively small, and the third-party enterprise chooses to seek rent from the local government to maximize its own interests. When $r = r'$, the profits of the third-party enterprise choosing rent-seeking and not rent-seeking are the same.

The results show that the central government supervises the third-party enterprise with a probability of $\frac{M - N - S}{gI}$. The supervision probability of the central government is positively correlated with the profit-cost difference of rent seeking of third-party enterprises ($M - N - S$), negatively related to the supervision capacity of the central government g , and negatively related to the punishment intensity of the central government for third-party enterprise I .

Therefore, the central government can effectively reduce the supervision probability of the central government and reduce the supervision input only by enhancing its supervision capacity and increasing the economic punishment for third-party enterprises.

- (2) Nash equilibrium conditions for the local government to choose whether to collude (accept rent-seeking).

Suppose that U_L^y is the expected return of the local government. We can then get the following results.

$$U_L^y = rt[g(S - J) + (1 - g)S] + (1 - r)tS \quad (7)$$

By treating U_L^y to obtain the first-order partial derivative of t , we can obtain the following results.

$$\frac{\partial U_L^y}{\partial t} = r[g(S - J) + (1 - g)S] + (1 - r)S \quad (8)$$

When equilibrium is realized, $\frac{\partial U_L^y}{\partial t} = 0$, i.e., U_L^y is independent of t . When $\frac{\partial U_L^y}{\partial t} = 0$, the solution is $r' = \frac{S}{gJ}$. When the supervision probability of the central government $r > r'$, the local government chooses not to accept rent-seeking from the third-party enterprise. When $r < r'$, the supervision intensity of the central government is relatively small, and the local government tends to accept rent-seeking from the third-party enterprise. When $r = r'$, the profits of the local government choosing to accept rent-seeking and not accept rent-seeking are the same.

The results show that the central government supervises the local government with a probability of $\frac{S}{gJ}$. The supervision probability of the central government is positively correlated with the income obtained by the local government from rent-seeking S , negatively related to the supervision capacity of the central government g , and negatively related to the punishment degree of the central government on the local government J .

Therefore, to reduce the supervision probability of the central government, we can improve the supervision capacity of the central government and increase the punishment of the central government for the local government.

(3) Nash equilibrium conditions for the central government to choose whether to supervise.

Suppose that U_C^y is the expected return of the central government. We can then get the following results.

$$U_C^y = rt\{g[I + J - (M - N) - H] + (1 - g)[-(M - N) - H]\} + r(1 - t)[g(-H) + (1 - g)(-H)] + (1 - r)t[-(M - N)] \quad (9)$$

By treating U_C^y to obtain the first-order partial derivative of r , we can obtain the following results.

$$\frac{\partial U_C^y}{\partial r} = t\{g[I + J - (M - N) - H] + (1 - g)[-(M - N) - H]\} + (1 - t)(-H) + t(M - N) \quad (10)$$

When equilibrium is realized, $\frac{\partial U_C^y}{\partial r} = 0$, i.e., U_C^y is independent of r . When $\frac{\partial U_C^y}{\partial r} = 0$, the solution is $t' = \frac{H}{(I+J)g}$. When the collusion probability between the local government and the third-party enterprise $t > t'$, the central government will choose the strategy of supervision. When $t < t'$, the central government will choose the strategy of non-supervision. When $t = t'$, the central government obtains the same profit from supervision as from non-supervision.

The results show that the local government and the third-party enterprise conspire with the probability of $\frac{H}{(I+J)g}$. The probability of collusion is positively correlated with the supervision cost of the central government H , negatively correlated with the supervision capacity of the central government g , and negatively correlated with the punishment intensity of the central government for the two $(I + J)$.

Therefore, the behaviors of the local government and the third-party enterprise that conspire to cheat the central government can be reduced by increasing the penalties for the local government and the third-party enterprise, improving the supervision capacity of the central government and reducing the supervision cost of the central government.

5. Conclusions

This paper conducts game analyses of participants' behavioral strategies of the third-party soil pollution control under Chinese-style fiscal decentralization, and the main conclusions are as follows.

- In the process of the third-party soil pollution control, there are three types of participants: government, enterprise, and society. In order to maximize their own interests, all participants in the third-party soil pollution control may make the choices of behavioral strategies.
- Since the central government cannot obtain all the information and realize comprehensive supervision, local governments and third-party enterprises with more information gain an advantage in the game process. Chinese-style fiscal decentralization mainly influences the behaviors of local governments in the third-party soil pollution control, which results in a low level and low efficiency of third-party soil pollution control in China.
- Local governments may choose not to implement or passively implement the third-party soil pollution control policies of the central government while increasing investment in economic growth. Local governments may also choose to conspire with third-party enterprises when implementing the third-party soil pollution control policies.
- In terms of internal factors, improving the income of local governments and third-party enterprises in the third-party soil pollution control can guide the behaviors of all participants. In terms of external factors, enhancing the central government's supervision probability and capacity and strengthening the central government's punishment for behavioral dissimulation can effectively reduce behavioral dissimulation in the third-party soil pollution control.

6. Discussion and Policy Suggestions

The introduction of the third-party soil pollution control can theoretically increase social investment in environmental control and improve the soil control efficiency. However, the third-party soil pollution control is not completely without defects. The third-party soil pollution control also has problems of the third-party control of environmental pollution. According to the current research, the existing problems mainly include lagging management concept, financing difficulties, low efficiency of environmental supervision, and technical obstacles [85,86]. The policy suggestions for promoting third-party control of environmental pollution are mainly put forward from the perspectives of finance, law, and supervision [87–89]. To implement the third-party environmental pollution control projects, it is necessary to innovate the investment and financing mode of environmental protection, and form a market-oriented and diversified investment and financing pattern [90]. While setting high standards for pollutant discharge, government departments should improve the monitoring and supervision system, strengthen the management of pollutant discharge by enterprises, and impose more severe penalties on excessive emissions [91].

Thus, some studies have made suggestions to deal with this issue using normative study under the assumption that participants are positive and information is complete. However, this assumption is inconsistent with the reality that local government competition under fiscal decentralization will lead to behavioral dissimulation and information is incomplete. We attempt to overcome this problem by applying a mixed strategy game model in this study. To guide the behaviors of participants in the third-party soil pollution control and promote the development of the third-party soil pollution control, this paper provides the following policy suggestions according to the game analysis results.

- (1) Dividing the administrative powers between the central and local government in third-party control

It is suggested to reduce the crossover of functions between the central government and local governments concerning third-party control. The central government can devolve authority over duties that can be performed by local governments. In addition, the adjustment of the government powers at all levels should be regulated through legal procedures rather than through arbitrary changes based on the administrative power to fundamentally correct the financial relations between governments at all levels and eliminate the institutional factor of financial difficulties at the grassroots level.

- The central government is mainly responsible for the nationwide third-party control of soil pollution as follows: (i) the legislation on the third-party soil pollution control, the formulation of national soil pollution policies and standards, and the formulation of medium and long-term plans for the third-party soil pollution control, (ii) the investment in the third-party construction of environmental infrastructure for the public welfare and supervision of the national pollution control affairs of third-party agents, (iii) the coordination and supervision of local governments and third-party enterprises in the government's third-party soil pollution control, and (iv) the release of information concerning third-party soil pollution control on websites and other platforms to publicize third-party control patterns.
- Local governments are mainly responsible for the third-party control of soil pollution in their own jurisdictions, as follows: (i) the formulation of third-party control standards and the compilation of short and medium term plans for the third-party soil pollution control in jurisdictions, (ii) the entrustment of third-party enterprises to treat the soil pollution within the local government's jurisdiction, such as domestic waste disposal, and the entrustment of third-party enterprises to build environmental infrastructure, (iii) the coordination and supervision of pollutant-discharging enterprises and third-party enterprises in the third-party soil pollution control entrusted by pollutant-discharging enterprises, and (iv) the release of information of third-party soil pollution control on local websites and other platforms to publicize third-party control patterns.

(2) Building appraisal systems for the local government's environmental protection performance

In addition to social and economic indicators, the central government should include environmental indicators as an important part of the local government performance appraisal system. The subjects of local governments' environmental protection performance appraisals should be enriched.

- Establishing a scientific environmental performance appraisal index system. On the basis of the establishment of a unified national assessment index, a differentiated performance assessment index system can be established according to the development level and environmental resource of each region. For example, in economically underdeveloped areas, development is still regarded as one of the important goals at present, and the weight of environmental protection indicators in government performance assessment indicators can be appropriately reduced on the basis of the unified national minimum weight. The weight of the soil pollution control assessment index can be increased in areas with serious soil pollution.
 - Enriching the subjects of local governments' environmental performance assessment. The central government puts forward corresponding solutions based on the current assessment standards and content. The self-assessment of local governments can be conducted from the aspects of the environmental protection process, results, and impact. The assessment results of the Communist Party of China can be used as an important reference for the appointment of officials. People's congresses and the standing committees of governments at all levels can supervise and assess the environmental protection work. A third-party evaluation agency can be selected to obtain objective and fair evaluation results. The effective feedback of individuals, social organizations, and news media on environmental protection effects can also be included to promote the public participation in environmental protection assessment.
- (3) Constructing environmental regulation mechanisms involving the government, market, and society

On the basis of disclosing environmental information, the government, market, and society should form a "trinity" environmental supervision mechanism to achieve comprehensive environmental supervision.

- These entities can improve the level of government supervision by enhancing the capability of testing personnel and upgrading environmental testing technology. The standing book records of polluting enterprises and third-party enterprises and the daily on-site inspection records of environmental protection departments can be established to augment the filing mechanism of supervision and management. Scientific and technological means can be used to promote government informatization and reduce the cost of government supervision.
 - They can build a market supervision system by designing a third-party control market information-sharing platform and encouraging third-party enterprises to disclose the basic information of enterprises and third-party control projects. A credit list of third-party enterprises can be established, and illegal third-party control enterprises can be publicized on the information-sharing platform in accordance with relevant provisions.
 - The role of social supervision should be utilized. On the basis of telephone reports, local governments have expanded their reporting platforms through official MicroBlog and WeChat, formulated methods for reporting with rewards, and rewarded informants who disclosed violations. For major cases, the media can be used to increase exposure and play the correct role in guiding public opinion. The communication and coordination among ENGOs, other social groups, and local governments can be strengthened.
- (4) Formulating the incentive and restraint policies for the participants in the third-party soil pollution control

Economic means are adopted to stimulate and restrain the behavior of each participant under market conditions. The government can establish a system of rewards and punishments while giving full play to the guiding role of fiscal policy, which is conducive to mobilizing the enthusiasm of all participants.

- When giving full play to the role of fiscal policy, the central government can set up a special fund for third-party control, strengthen payment for ecosystem services in fiscal transfer payments, and realize horizontal transfer payments for third-party control. We can implement preferential tax policies such as environmental protection taxes, income taxes, value-added taxes, property taxes, and land use taxes. To promote technological innovation in the environmental protection of third-party enterprises, subsidies for research and the development of pollution control technology can be adopted, and extra deductions before taxes for research and development expenses can be implemented in the final income tax settlement.
- A system of rewards and punishments should be established. Third-party control with outstanding effects can be rewarded, and illegal speculation and collusion can be punished more severely. The State Council may collect typical cases of third-party control from the entire country every year, compile a collection and publish it, and award third-party enterprises compiled in the collection. When a pollution accident occurs in a third-party control project under construction and operation, the third-party enterprise should be subject to economic punishment. When a pollution accident occurs in a third-party control project operated by the entrusting party, economic penalties should be imposed on the third-party enterprise and the entrusting party simultaneously.

The scientific formulation, effective implementation, and performance evaluation of the third-party soil pollution control policy constitute a complete policy process, which is the basis for determining whether the policy reaches the expectation, and, therefore, for adjustment, continuation, or termination. It needs to be estimated that the proposal of third-party soil pollution control can actually promote the level and efficiency of soil pollution control. In future studies, we will promote the empirical analysis of performance evaluation of third-party soil pollution control. By using the third-party control information platform and the input and output index method, we will measure the efficiency of the

third-party soil pollution control, which provides empirical support for the government to improve policies.

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