systems

MDPI

Article

Research on the Incentive Mechanism of Environmental Responsibility of Polluting Enterprises Considering Fairness Preference

Gedi Ji, Qisheng Wang * and Qing Chang

School of Economics and Management, Inner Mongolia University of Technology, Hohhot 010051, China; jigd@imut.edu.cn (G.J.); changqingimut@126.com (Q.C.)
* Correspondence: 20221100308@imut.edu.cn

Abstract: More and more attention has been paid to the environmental problems brought about by the development of the global economy. Based on the principal–agent theory, this paper constructs an incentive model for the government and polluting enterprises and explores the incentive problem of the government and polluting enterprises in undertaking environmental responsibility. At present, the research on the incentive of polluting enterprises focuses on the hypothesis of 'rational man', and less on the fairness preference of polluting enterprises. However, in other research fields, it has been proved that fairness preference has a great influence on the incentive mechanism. Fairness preference is introduced into the incentive model, and the incentive effect of polluting enterprises before and after considering fairness preference is compared and analyzed. This study found that the reward and punishment mechanism considering fairness preference can increase the behavior of polluting enterprises to assume environmental responsibility and limit the behavior of not assuming environmental responsibility. The stronger the fairness preference of polluting enterprises, the stronger the role of incentive mechanism; after considering the fairness preference, the government's subsidies and penalties for polluting enterprises will increase with the increase in the fairness preference of polluting enterprises, and the expected benefits of polluting enterprises and the government will also increase; under the same incentive mechanism, the income of polluting enterprises with strong fairness preference is higher, but the government's income is lower. Adopting the same incentive mechanism for different polluting enterprises will cause the loss of social benefits. After considering the fairness preference, the incentive strategy set up to a certain extent promotes the polluting enterprises to assume environmental responsibility and realize the coordinated development of the economy and the environment. Therefore, the government should set reasonable subsidy and punishment policies according to the fairness preference of polluting enterprises to encourage enterprises to fulfill their environmental responsibilities, improve environmental quality and reduce pollution.

Keywords: fairness preference; incentive mechanism; principal–agent theory; polluting enterprises; environmental responsibility

check for updates

Academic Editor: Shanyue Jin

Received: 24 December 2024
Revised: 2 February 2025
Accepted: 5 February 2025
Published: 8 February 2025

Citation: Ji, G.; Wang, Q.; Chang, Q. Research on the Incentive Mechanism of Environmental Responsibility of Polluting Enterprises Considering Fairness Preference. *Systems* **2025**, *13*, 103. https://doi.org/10.3390/systems13020103

Copyright: © 2025 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

In industrial countries, the conflict between economic development and environmental protection has become a worldwide problem [1,2]. Therefore, strengthening environmental regulation and coordinating the balance between the environment and economic growth have become crucial to sustainable development [3]. Faced with this challenge, international

societies have formulated many environmental policies for energy saving and emission reduction, such as The Paris Agreement in 2015 [4]. Moreover, the European Commission has adopted a set of proposals to make the EU's climate, energy, transport and taxation policies fit for reducing net greenhouse gas emissions by at least 55% by 2030 [5], with many others supporting eco-innovation [6].

Polluting enterprises are the main source of pollution and carbon emissions, and the realization of energy conservation and emission reduction in polluting enterprises is the key to achieving global environmental protection. The government plays an important role in this. As a policy maker and supervisor of polluting enterprises, the government has an important impact on energy conservation and emission reduction in polluting enterprises. The government realizes the control of polluting enterprises by punishing polluting enterprises, but the effect is often not significant. At the same time, polluting enterprises are reluctant to assume environmental responsibility due to external factors, which is not conducive to the sustainable development of the economy. Therefore, it is necessary for the government to incentivize polluting enterprises to assume environmental responsibility through reasonable incentive policies to realize the coordinated development of the economy and the environment.

Although governments and the international community have adopted a number of policies to deal with environmental pollution, enterprises, as the main body of pollution emissions, still have a significant lack of environmental responsibility. In order to pursue short-term economic interests, some enterprises choose to ignore environmental protection requirements and even evade supervision. At the same time, in solving the problem of environmental governance, the traditional incentive mechanism design often ignores the fairness preference of the subject of behavior. However, fairness preference is an important psychological factor affecting individual behavior choice; that is, when making decisions, the subject not only pays attention to its own absolute income but also pays attention to the fairness of income distribution. This factor has an important impact on the actual effect of incentive policies (such as subsidies and penalties). For example, if the incentive measures provided by the government are considered to be unfairly distributed, it may lead to negative reactions from enterprises and weaken the effect of policy implementation. Therefore, it is of great significance to take fairness preference into consideration when designing an incentive mechanism for environmental governance.

Research on the environmental responsibility of polluting enterprises has mainly studied the impact of internal and external factors on the environmental responsibility of polluting enterprises. The internal influencing factors of polluting enterprises mainly include corporate culture, information disclosure, managers' literacy, financial performance and so on. Different scholars study the impact of environmental responsibility on polluting enterprises from different aspects, mainly focusing on Chinese traditional culture [7], information disclosure [8–12], CEO's education level [13], financial performance [14], managers' environmental protection experience [15], regulatory distance [16], internal control methods [17] and management characteristics [18] on the environmental responsibility of polluting enterprises. The external influencing factors of polluting enterprises mainly include the external environment, media attention, public attention, policies and regulations, competition in the same industry and government intervention. Scholars mainly study haze, media attention [19], public attention [20–22], environmental regulation [23–26], environmental liability insurance [27], green finance [28,29], mergers and acquisitions [30], government green governance measures [31], government environmental subsidies and non-environmental subsidies [32]. In addition, they also study the impact of corporate environmental responsibility on corporate green innovation [33].

The research on incentive mechanisms for polluting enterprises mainly focuses on the design of optimal contracts and the effectiveness of incentive mechanisms. The research on the optimal contract design includes the following aspects: the incentive mechanism design of incorporating corporate environmental responsibility into management incentives [34]; the design of a multi-task environmental governance incentive mechanism based on principal–agent theory [35]; a punishment mechanism for polluting enterprises with excessive emissions [36,37]; incentive mechanisms for polluting enterprises, government regulators and government planning agencies at different costs [38]. The research on the effectiveness of incentive mechanisms mainly focuses on the impact of the combination of incentive policy and regulatory policy on the behavior of polluting enterprises in different environments [39] and the impact of incentive mechanisms based on green innovation on enterprise development [40]. Based on the evolutionary game, a four-group evolutionary game model of green technology innovation activities of government, public, polluting enterprises and pollution-free enterprises under environmental regulation is constructed to study the effectiveness of incentive environmental regulation [41]. An analysis of the incentive effect of market incentive environmental regulation on enterprise green innovation [42]; the incentive effect and restraint effect of green credit policy on enterprises [43]; and the impact of purchasing environmental pollution liability insurance as an incentive tool on corporate green innovation [44] have been studied.

In the application of fairness preference in incentive mechanisms, the research on fairness preference is mainly carried out in the fields of supply chain [45,46], enterprise venture capital [47,48], PPP project [49,50], enterprise performance [51], major projects [52] and regional industrial planning [53]. The incentive mechanism is controlled by income distribution [54]. In the research on incentive mechanisms based on income distribution, the tournament incentive mechanism in large-scale water diversion projects based on fairness preference has been studied. Polluting enterprises with different fairness preferences need different incentive coefficients to ensure the optimal effort level [55]. Based on the shared contract design of fairness preference, the best effort level of performance pay is studied [56]. Based on the crowdsourcing incentive mechanism of participants' fairness preference, this paper studies the influence of fairness preference on benefit distribution [57].

Through the above literature, it can be found that the environmental responsibility of polluting enterprises is greatly influenced by the government, and the environmental responsibility of polluting enterprises is promoted through supervision and environmental regulation. In the research on the incentive mechanism of polluting enterprises, the government promotes polluting enterprises to assume environmental responsibility through policy regulation. The research on fairness preference in various fields shows that fairness preference explains the difference in the behavioral decision-making of participants. Fairness preference will affect the incentive coefficient and income distribution required by participants, explaining the game's experimental results and economic behavior that consider pure self-interest preferences but cannot be explained by them.

Compared to previous studies, this study makes three significant contributions. First, while earlier research on the incentives of polluting enterprises predominantly emphasized the rational man hypothesis, it gave less consideration to the fairness preferences of such enterprises. However, in other fields of research, it has been proven that fairness preferences have a significant impact on incentive mechanisms. This paper studies the impact of the fairness preference of polluting enterprises on the incentive mechanism. Second, regarding the incentive mechanism, the government's means of incentivization are through policy regulation. The government promotes polluting enterprises to improve environmental problems through policy rewards and punishments. This relationship can be regarded as a principal–agent relationship. There are few studies on the incentive mechanism of

environmental responsibility of polluting enterprises based on the principal–agent theory. Using the principal–agent theory to analyze the problem is more in line with the governance of polluting enterprises in practice. Third, past research mainly focused on the government's use of policy subsidies and penalties to promote polluting enterprises to assume environmental responsibilities. However, polluting enterprises may also adopt opportunistic behavior, such as stealing and leaking emissions, in the process of assuming environmental responsibilities. Linking government subsidies and penalties with the speculative behavior of polluting enterprises can better incentivize them to assume environmental responsibilities.

Therefore, on the basis of previous studies, the principal–agent incentive model of government and polluting enterprises is constructed, and the fairness preference is introduced into the incentive model. The government influences the environmental responsibility of polluting enterprises through subsidies and punishments. At the same time, the speculative level factors that represent the environmental responsibility of polluting enterprises are introduced into the model. At the same time, the incentive model of rewards and punishments before and after considering fairness preference is compared and analyzed, and the influence of fairness preference on the incentive effect and environmental responsibility of polluting enterprises is studied.

2. Model Hypothesis and Construction

The main basic symbols in Table 1. Variables are selected from Wang [33], Zhou [39], Li [41], Zhang [44] and Xu [45].

Table 1. Symbol description.

Variables	Meaning of Variables	Range
T	The probability that the government finds that polluting enterprises assume corporate environmental responsibility	$T \in [0,1]$
E	The social benefits of environmental responsibility for polluting enterprises	$E > 0$
a	The level of effort of polluting enterprises to assume environmental responsibility	$a \in [0,1]$
D	The economic benefits of polluting enterprises not assuming environmental responsibility	$D > 0$
A	The operating income of polluting enterprises	$A > 0$
β	The proportion of government subsidies for environmental responsibility of polluting enterprises	$\beta \in [0,1]$
R_j	The utility function of polluting enterprises after the adjustment of fairness preference	$R_j > 0$
W	The government's punishment for polluting enterprises not assuming environmental responsibility	$W > 0$
V	The effort cost of polluting enterprises to bear environmental responsibility	$V > 0$
L_j	The decision of polluting enterprises is the income of the government and polluting enterprises, respectively	$L_j > 0$
$1-q$	The probability that polluting enterprises do not bear environmental responsibility	$1-q \in [0,1]$
G	The government's tax revenue on polluting enterprises	$G > 0$
λ_1	The pride preference intensity coefficient of polluting enterprises	$\lambda_1 \in [0,1]$
λ_2	The jealousy preference intensity coefficient of polluting enterprises	$\lambda_2 \in [0,1]$

Table 1. *Cont.*

Variables	Meaning of Variables	Range
b	Pollution enterprises do not bear the level of environmental responsibility speculation	$b \in [0,1]$
B	The speculative cost that polluters do not bear environmental responsibility.	$B > 0$
q	The probability of polluting enterprises undertaking corporate environmental responsibility	$q \in [0,1]$
F	The social benefit loss of polluting enterprises not assuming environmental responsibility	$F > 0$
ε	Uncertain factors and obey normal distribution	$\varepsilon \in (0, \sigma^2)$
c	The cost coefficient of polluting enterprises to bear and not bear environmental responsibility	$c > 0$
H	The probability that the government finds that polluting enterprises do not bear corporate environmental responsibility	$H > 0$
S_j	Represent the income of polluting enterprises and the government, respectively	$F > 0$
j	Polluting enterprises and government	$j = 1, 2$
M	The cost of government supervision	$M > 0$
p	Loss coefficient	$p > 1$

Hypothesis 1. *According to the classical H-M principal–agent model, when polluting enterprises assume corporate environmental responsibility, the social benefits are represented by a linearly increasing function:* $E = a + \varepsilon$.

Hypothesis 2. *When the polluting enterprises do not bear the corporate environmental responsibility, the income obtained by the polluting enterprises is a linear increasing function:* $D = b + \varepsilon$.

Hypothesis 3. *The government's punishment for polluting enterprises not assuming corporate environmental responsibility is a linear increasing function, which is related to the speculative level of polluting enterprises not assuming corporate environmental responsibility:* $W = xb + \varepsilon$.

Hypothesis 4. *The resulting environmental losses are borne by the government:* $F = pb + \varepsilon$.

Hypothesis 5. *The effort cost of polluting enterprises to assume corporate environmental responsibility is* $V = \frac{1}{2}ca^2$.

Hypothesis 6. *The speculative cost of polluting enterprises not assuming corporate environmental responsibility is* $B = \frac{1}{2}cb^2$.

Hypothesis 7. *The expected revenue function of polluting enterprises and the government* S_j:

$$S_1 = A + qT[\beta E - V] - Vq(1-T) + (1-q)H[D - W - B]) + (D - B)(1-q)(1-H) \quad (1)$$

$$S_2 = G + qT(1-\beta)E + q(1-T)E + (1-q)H(W - F) + q(1-I)E - (1-q)(1-H)F - M \quad (2)$$

Hypothesis 8. *The utility function of polluting enterprises and the government:*

$$\begin{aligned} R_1 &= A + qT[\beta E - V] - qV(1-T) + (1-q)H[D - W - B] + (D-B)(1-q)(1-H) \\ &= A + qT\left(\beta a - \tfrac{1}{2}ca^2\right) - \tfrac{1}{2}qca^2(1-T) + \\ &(1-q)H\left[(1-x)b - \tfrac{1}{2}cb^2\right] + \left(b - \tfrac{1}{2}cb^2\right)(1-q)(1-H) \end{aligned} \tag{3}$$

$$\begin{aligned} R_2 &= G + qT(1-\beta)E + q(1-T)E + (1-q)H(W-F) - (1-q)(1-H)F - M \\ &= G + aqT(1-\beta) + aq(1-T) + (1-q)H(xb - pb) - (1-q)(1-H)pb - M \end{aligned} \tag{4}$$

3. Models Without Considering Fairness Preference

To maximize the expected utility of the government under the premise of satisfying the participation constraints (IR) and incentive compatibility (IC) of the government and polluting enterprises, the following principal–agent model is constructed:

$$Max : R_2$$
$$_{(\mathrm{IR})} R_1 \geq R_0$$

R_0 is the retained earnings of polluting enterprises.

$$_{(\mathrm{IC})} a \in argmax(R_1)\ b \in argmax(R_1) \tag{5}$$

The solution is solved by partial derivation. Firstly, the first-order condition of IC constraint is $\frac{\partial R_1}{\partial a} = 0$, $\frac{\partial R_1}{\partial b} = 0$, $\frac{\partial^2 R_1}{\partial a} < 0$, $\frac{\partial^2 R_1}{\partial b} < 0$, and the optimal level of effort and speculation is obtained.

First, determine whether there is an optimal solution:

$$\frac{\partial R_1}{\partial a} = q(T\beta - ca) = 0 \tag{6}$$

$$\frac{\partial R_1}{\partial b} = (1-q)(1 - xH - cb) = 0 \tag{7}$$

$$\frac{\partial^2 R_1}{\partial a} = -cq < 0 \tag{8}$$

$$\frac{\partial^2 R_1}{\partial b} = -c(1-q) < 0 \tag{9}$$

$\frac{\partial^2 R_1}{\partial a} < 0$, $\frac{\partial^2 R_1}{\partial b} < 0$. Therefore, the objective function of the effort level and the speculative level have the optimal solution.

$$a = \frac{T\beta}{c} \tag{10}$$

$$b = \frac{1 - xH}{c} \tag{11}$$

Bring $a = \frac{T\beta}{c} b = \frac{1-xH}{c}$ to the objective function. The optimal subsidy coefficient and penalty coefficient are obtained.

$$\frac{\partial R_2}{\partial \beta} = \frac{qT}{c} - \frac{2qT^2\beta}{c} = 0 \tag{12}$$

$$\frac{\partial R_2}{\partial x} = \frac{(1-q)\left(H - 2xH^2 + pH\right)}{c} = 0 \tag{13}$$

$$\frac{\partial^2 R_2}{\partial \beta} = -\frac{2qT^2}{c} - \frac{2\lambda qT^2}{c(1+\lambda)} < 0 \tag{14}$$

$$\frac{\partial^2 R_2}{\partial x} = -\frac{2(1-q)H^2}{c} - \frac{2\lambda(1-q)H^2}{c(1+\lambda)} < 0 \tag{15}$$

$\frac{\partial^2 R_1}{\partial \beta} < 0$, $\frac{\partial^2 R_1}{\partial x} < 0$. Therefore, the objective function of the subsidy level and the penalty level has the optimal solution.

$$\beta = \frac{1}{2T} \tag{16}$$

$$x = \frac{1+p}{2H} \tag{17}$$

The government's regulatory intensity is negatively correlated with the government's optimal reward and punishment mechanism.

From $\frac{\partial \beta}{\partial T} = -\frac{1}{2T^2} < 0 \frac{\partial x}{\partial H} = -\frac{1+p}{2H^2} < 0$, it can be seen that the derivatives of the subsidy coefficient and the penalty coefficient on the probability of the government identifying whether the polluting enterprise bears environmental responsibility are less than zero, which are both decreasing functions. Obviously, the government's regulatory intensity directly affects the probability of discovering the behavior of polluting enterprises and is positively correlated. Therefore, the government will strengthen the supervision of polluting enterprises, and the optimal incentive coefficient and optimal penalty coefficient of polluting enterprises will also be reduced.

4. Models Considering Fairness Preference

Considering the necessity of fairness preference of polluting enterprises, the previous analysis is mainly based on the assumption that polluting enterprises are completely rational. With a series of experiments such as the ultimatum, gift exchange game, trust game, dictatorship game and public goods game, it is proven that people not only pay attention to their own interests but to the interests of others and also have a fairness preference. At the same time, in practice, polluting enterprises are often limitedly rational: polluting enterprises will measure the benefits or losses of decision-making, compare with the benefits or losses of this decision for the government and society, and produce utility through comparison [58,59].

Hypothesis 9. *The degree of fairness preference depends on the income level of the decision-making of the polluting enterprises and the income level of the government. We express λ_i as the degree of fairness preference of polluting enterprises; the higher the λ_i threshold, the stronger the preference for fairness. The fairness preference of the actor can be divided into two categories: the proud tendency that one's own income is higher than the other's and the jealous tendency that the other's income is higher than their own [60].*

$$L_1 = qT[\beta E - V] - Vq(1-T) + (1-q)H[D-W-B]) + (D-B)(1-q)(1-H) \tag{18}$$

$$\begin{aligned} L_2 = {} & qT(1-\beta)E + q(1-T)E + (1-q)H(W-F) + q(1-I)E \\ & -(1-q)(1-H)F - M \end{aligned} \tag{19}$$

$$\begin{aligned} R_1 = {} & A + qT[\beta E - V] - Vq(1-T) + (1-q)H[D-W-B] \\ & +(D-B)(1-q)(1-H) + \lambda_1 MAX[(L_1 - L_2), 0] - \lambda_2 MAX[(L_2 - L_1), 0] \end{aligned} \tag{20}$$

$$R_2 = G + qT(1-\beta)E + q(1-T)E + (1-q)H(W-F) - (1-q)(1-H)F - M \tag{21}$$

In order to facilitate the subsequent calculation $\lambda_1 = \lambda_2 = \lambda (0 < \lambda < 1)$, the coefficients of jealousy preference and pride preference are equal.

$$\begin{array}{l} R_1 = A + qT[\beta E - V] - qV(1-T) + (1-q)H[D - W - B] + (D-B)(1-q)(1-H) + \lambda(L_1 - L_2) \\ = A + qT\left[\beta a - \frac{1}{2}ca^2\right] - \frac{1}{2}qca^2(1-T) + \\ (1-q)H\left[1 - xb - \frac{1}{2}cb^2\right] + \left(b - \frac{1}{2}cb^2\right)(1-q)(1-H) \\ +\lambda\left(\begin{array}{l} qT\left(\beta a - \frac{1}{2}ca^2\right) - \frac{1}{2}qca^2(1-T) + (1-q)H\left[(1-x)b - \frac{1}{2}cb^2\right] + \left(b\frac{1}{2}cb^2\right) \\ (1-q)(1-H) - aqT(1-\beta) + aq(1-T) + (1-q)H(xb - pb) - (1-q)(1-H)pb \end{array} \right) \end{array} \tag{22}$$

$$\begin{array}{l} R_2 = G + qT(1-\beta)E + q(1-T)E + (1-q)H(W-F) - (1-q)(1-H)F - M \\ = G + aqT(1-\beta) + aq(1-T) + (1-q)H(xb - pb) - (1-q)(1-H)pb - M \end{array} \tag{23}$$

To maximize the expected utility of the government under the premise of satisfying the participation constraints (IR) and incentive compatibility (IC) of the government and polluting enterprises, the following principal–agent model is constructed:

$$Max : R_2$$

$$_{(\mathrm{IR})} R_1 \geq R_0$$

R_0 is the retained earnings of polluting enterprises.

$$_{(\mathrm{IC})} a \in argmax(R_1) b \in argmax(R_1) \tag{24}$$

The solution is solved by partial derivation. Firstly, the first-order condition of IC constraint is $\frac{\partial R_1}{\partial a} = 0$, $\frac{\partial R_1}{\partial b} = 0$, $\frac{\partial^2 R_1}{\partial a} < 0$, $\frac{\partial^2 R_1}{\partial b} < 0$, and the optimal level of effort and speculation is obtained.

First, determine whether there is an optimal solution:

$$\frac{\partial R_1}{\partial a} = q(1+\lambda)(T\beta - ca) - \lambda q(1 - T\beta) = 0 \tag{25}$$

$$\frac{\partial R_1}{\partial b} = (1+\lambda)(1-q)(1 - xH - cb) - \lambda(1-q)(Hx - p) = 0 \tag{26}$$

$$\frac{\partial^2 R_1}{\partial a} = -cq(1+\lambda) < 0 \tag{27}$$

$$\frac{\partial^2 R_1}{\partial b} = -c(1+\lambda)(1-q) < 0 \tag{28}$$

$\frac{\partial^2 R_1}{\partial a} < 0$, $\frac{\partial^2 R_1}{\partial b} < 0$. Therefore, the objective function of the effort level and the speculative level have the optimal solution.

$$a = \frac{T\beta}{c} - \frac{\lambda(1 - T\beta)}{c(1+\lambda)} \tag{29}$$

$$b = \frac{1 - xH}{c} - \frac{\lambda(xH - p)}{c(1+\lambda)} \tag{30}$$

Bring $a = \frac{T\beta}{c} - \frac{\lambda(1-T\beta)}{c(1+\lambda)}$, $b = \frac{1-xH}{c} - \frac{\lambda(xH-p)}{c(1+\lambda)}$ to the objective function. The optimal subsidy coefficient and penalty coefficient are obtained.

$$\frac{\partial R_2}{\partial \beta} = \frac{qT}{c} - \frac{2qT^2\beta}{c} + \frac{2\lambda qT(1 - \beta T)}{(1+\lambda)c} = 0 \tag{31}$$

$$\frac{\partial R_2}{\partial x} = \frac{(1-q)\left(H - 2xH^2 + pH\right)}{c} - \frac{2\lambda H(1-q)(xH - p)}{c(1+\lambda)} = 0 \tag{32}$$

$$\frac{\partial^2 R_2}{\partial \beta} = -\frac{2qT^2}{c} - \frac{2\lambda qT^2}{c(1+\lambda)} < 0 \tag{33}$$

$$\frac{\partial^2 R_2}{\partial x} = -\frac{2(1-q)H^2}{c} - \frac{2\lambda(1-q)H^2}{c(1+\lambda)} < 0 \tag{34}$$

$\frac{\partial^2 R_1}{\partial \beta} < 0$, $\frac{\partial^2 R_1}{\partial x} < 0$. Therefore, the objective function of the subsidy level and the penalty level has the optimal solution.

$$\beta = \frac{1+3\lambda}{2T+4\lambda T} \tag{35}$$

$$x = \frac{1+p+\lambda+3p\lambda}{2H+4\lambda H} \tag{36}$$

The optimal subsidy coefficient and penalty coefficient of the government will increase with the increase in the fairness preference intensity of polluting enterprises.

From $\frac{\partial \beta}{\partial \lambda} = \frac{2T}{(2T+4\lambda T)^2} > 0 \frac{\partial x}{\partial \lambda} = \frac{2pH-2H}{(2H+4\lambda H)^2} > 0$, the derivative of the subsidy coefficient and the penalty coefficient on the fairness preference is greater than zero, which is an increasing function. Obviously, with the increase in the fairness preference intensity of the polluting enterprises, the optimal incentive coefficient and the optimal penalty coefficient of the government to the polluting enterprises will also increase.

The reward and punishment coefficients considering fairness preference and not considering fairness preference are shown in Table 2.

Table 2. Optimal incentive level and incentive coefficient.

	Not Considering Fairness Preference	**Considering Fairness Preference**
Effort level	$a = \frac{T\beta}{c}$	$a = \frac{T\beta}{c} - \frac{\lambda(1-T\beta)}{c(1+\lambda)}$
Speculative level	$b = \frac{1-xH}{c}$	$b = \frac{1-xH}{c} - \frac{\lambda(xH-p)}{c(1+\lambda)}$
Subsidy coefficient	$\beta = \frac{1}{2T}$	$\beta = \frac{1+3\lambda}{2T+4\lambda T}$
Penalty coefficient	$x = \frac{1+p}{2H}$	$x = \frac{1+p+\lambda+3p\lambda}{2H+4\lambda H}$

5. Numerical Simulation Analysis

In order to verify the impact of the fair preference of polluting enterprises on the government's incentive mechanism, this paper uses MATLAB R2022a to simulate and analyze the polluting enterprises and the government within reasonable parameters. In order to ensure the rationality of the parameters, the above research is reasonably assigned.

5.1. The Relationship Between Government Regulation Strategy and Fairness Preference

According to the optimal subsidy and punishment obtained by the model considering fairness preference, the relationship between the fairness preference of polluting enterprises and the government regulation strategy is studied as an independent variable. It can be seen from Figures 1 and 2 that as the fairness preference coefficient increases, the optimal subsidies and penalties will increase, but the rate of increase will slow down. It shows that the incentive for polluting enterprises with a high fairness preference needs a high punishment and subsidy to ensure the best incentive effect, and vice versa for polluting enterprises with a low fairness preference.

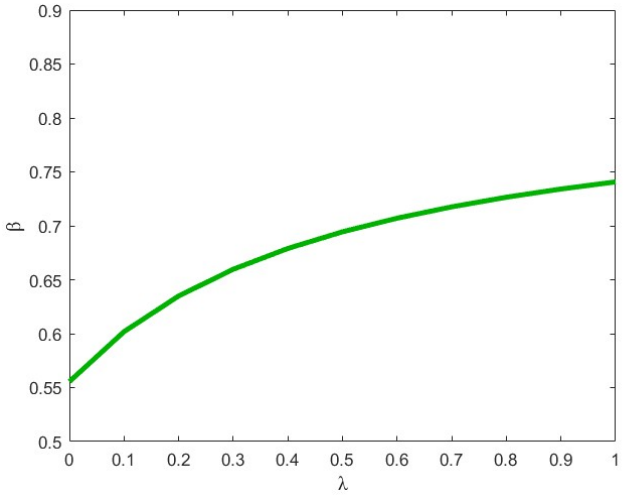


Figure 1. The relationship between fairness preference and the optimal reward coefficient.

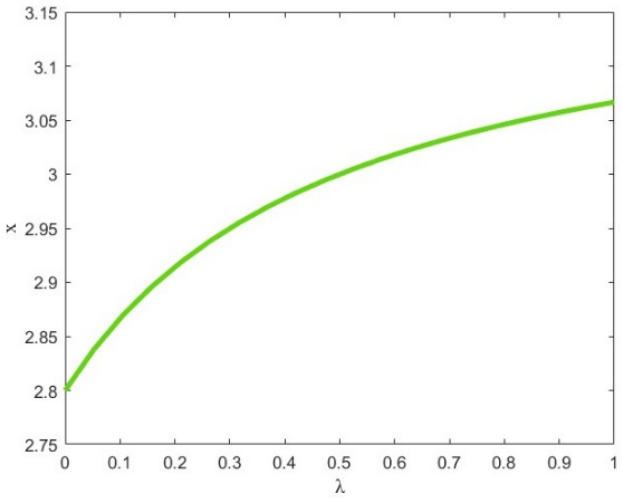


Figure 2. The relationship between fairness preference and the optimal penalty coefficient.

5.2. The Relationship Between Effort Level, Speculation Level and Fairness Preference

According to the optimal effort level and speculation level obtained by the model considering fairness preference, the relationship between the fairness preference of polluting enterprises and the optimal effort level and speculation level is studied as an independent variable. From Figure 3, it can be seen that when the fairness preference is zero, the polluting enterprises are in a state with a high speculation level and a low effort level. With the increase in fairness preference, the speculation level of polluting enterprises decreases continuously, while the optimal effort level of polluting enterprises increases continuously. It can be seen that considering fairness preference is conducive to reducing the illegal discharge of polluting enterprises, increasing the behavior of polluting enterprises to actively assume social responsibility, and more conducive to the realization of the coordinated development of the economy and the environment.

5.3. The Relationship Between Income and Fairness Preference

The optimal speculative level, the optimal effort level, the optimal subsidy and the optimal penalty are brought into the expected return of the polluting enterprises and the government, and the fair preference of the polluting enterprises is used as the independent variable to study the relationship between the expected return of the polluting enterprises and the government. It can be seen from Figure 4 that with the increase in fairness

preference, the expected returns obtained by polluting enterprises and governments are increasing. Combined with Figures 1, 2 and 4, it can be seen that with the increase in fairness preference, the government's optimal subsidy and optimal punishment strategy for polluting enterprises are increasing, and the expected returns of the government and polluting enterprises are also increasing. Providing high rewards and high penalties for polluting enterprises with high fairness preferences will improve the overall efficiency of enterprises and society to a certain extent.

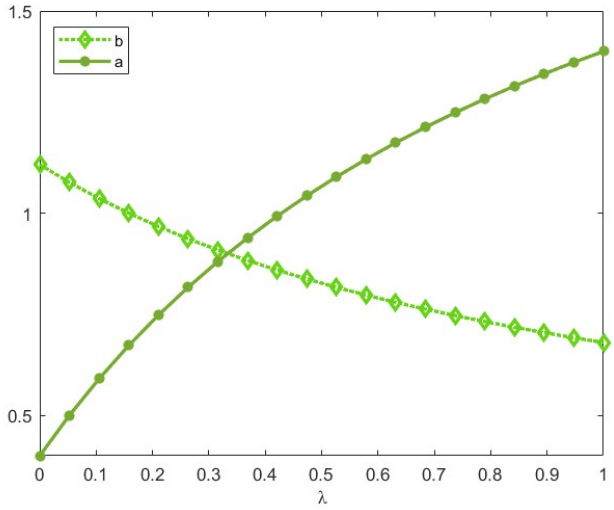


Figure 3. The relationship between fairness preference and the level of speculation and effort.

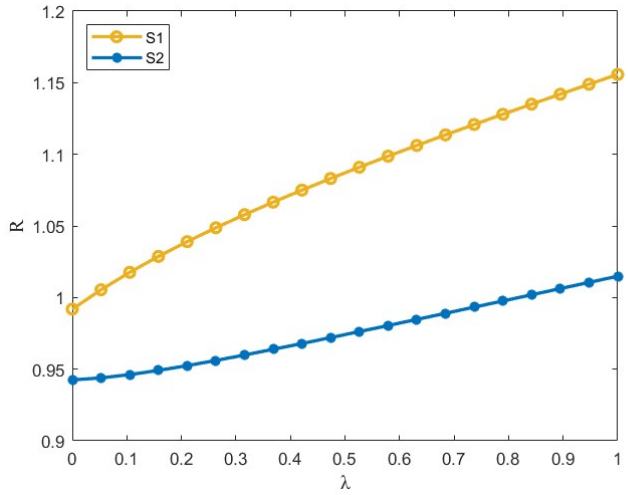


Figure 4. The relationship between fairness preference and expected return.

5.4. Comparative Analysis of Whether to Consider the Benefits of Fairness Preference

Bring the optimal speculation level and the optimal effort level to the expected returns of polluting enterprises and the government, and use the subsidy coefficient and the penalty coefficient as independent variables to study the relationship between the expected returns of polluting enterprises and the government. According to Figures 5 and 6, it can be seen that for the expected income of polluting enterprises, the income is the lowest when the fairness preference is not considered, followed by the low fairness preference $\lambda = 0.2$ and the highest income is the high fairness preference $\lambda = 0.8$. With the increase in fairness preference and the same subsidy and punishment strategy, the expected return of polluting enterprises also increases. For the expected revenue of the government, the revenue is the highest when the fairness preference is not considered, followed by the low fairness preference $\lambda = 0.2$, and the lowest revenue is the high fairness preference $\lambda = 0.8$. With

the increase in fairness preference and the same subsidy and punishment strategy, the government's expected return also decreases. However, through Figures 1, 2 and 4, it can be seen that the greater the fairness preference coefficient, the greater the penalty coefficient, the reward coefficient and the government's income. Under the optimal subsidy and punishment strategy, the expected return of the government increases with the increase in the fairness preference coefficient. Therefore, adopting different reward and punishment policies for polluting enterprises with different fairness preferences can achieve the best incentive effect.

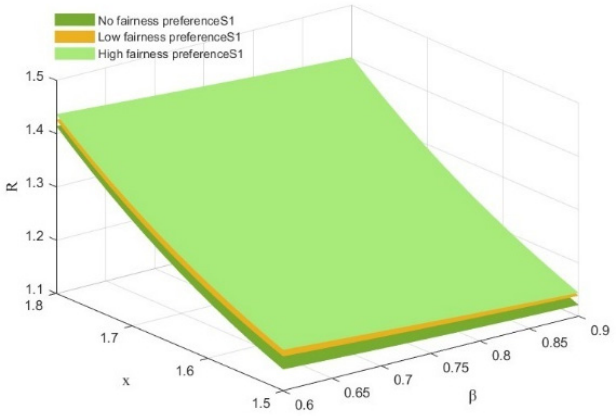


Figure 5. The relationship between the expected return of polluting enterprises and the reward and punishment coefficient.

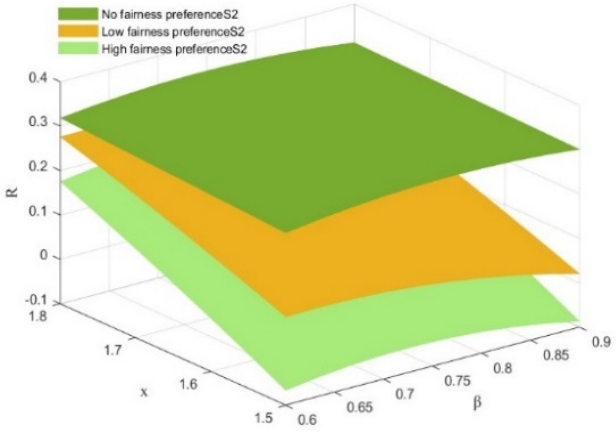


Figure 6. The relationship between the government's expected revenue and the coefficient of rewards and punishments.

6. Discussion

Promoting polluting enterprises to assume environmental responsibility is conducive to environmental protection and the sustainable development of enterprises. The incentive mechanism of government departments has an important impact on enterprises' environmental responsibility. Therefore, this paper focuses on the environmental responsibility of polluting enterprises and uses the principal–agent theory to construct an incentive model. This model combines fairness preference to explore the impact of fairness preference on the environment of polluting enterprises and demonstrates the research results through simulation analysis. This study provides suggestions for the government to promote polluting enterprises to assume environmental responsibility. In the process of model construction and analysis, this paper combines the fairness preference of polluting enterprises and the principal–agent incentive model and transforms the traditional economic man hypothesis into the social man hypothesis so that the research results are more in line with reality. First

of all, when ignoring the fairness preference of polluting enterprises, the government's reward and punishment incentive mechanism has different effects on the environmental responsibility of polluting enterprises. In Figure 5, comparing the influence of the change in the government's incentive coefficient and penalty coefficient, it is found that a punishment is more effective than a reward in the same degree [35], which is consistent with the previous loss aversion theory [61]. However, to a certain extent, with the increase in reward coefficient and penalty coefficient, the income of polluting enterprises will not increase but decrease [62,63]. At the same time, through the analysis of the optimal reward and punishment coefficient, it is found that government supervision can improve the level of efforts of polluting enterprises and reduce the level of speculation. It is verified that the government pays attention to the problem of environmental responsibility of polluting enterprises. Increasing the supervision of polluting enterprises can solve the problem of environmental governance of polluting enterprises at a lower cost [34]. Secondly, considering the incentive model after fairness preference, Li [64] and Pu [65] proved the impact of fairness preference on project revenue in supply chain projects and IPD projects. This paper finds that the fairness preference of polluting enterprises will have an impact on government incentive policies. Compared with previous studies, considering the fairness preference of polluting enterprises will increase the expected return of polluting enterprises, but the government's expected return will decrease, considering the optimal incentive mechanism will change. As shown in Figures 5 and 6, under the same incentive mechanism, considering fairness preference will increase the return of polluting enterprises, while the government's return will decrease. Under the optimal incentive mechanism, considering fairness preference will increase the expected return of the government and polluting enterprises, and the higher the fairness preference coefficient, the greater the expected return. Finally, previous studies have found that the impact of fairness preference on the incentive coefficient, the impact of fairness preference on the incentive coefficient of large-scale water diversion projects [55] and the level of employee effort [56] require differentiated incentive mechanisms. This paper finds the influence of fairness preference on the optimal reward and punishment coefficient. Through Figures 1 and 2, it is found that the stronger the fairness preference, the higher the optimal reward and punishment coefficient, leading to different incentives for different polluting enterprises.

7. Conclusions

In this paper, through the establishment of the principal–agent model, we examined the case of polluting enterprises with fairness preferences. Assuming that polluting enterprises have two behavioral tendencies, we measured their environmental responsibility through the level of effort and speculation. Due to the fairness preference, polluting enterprises pay attention to the benefits and losses brought by incentives to themselves and the government, comparing these subsidies and penalties, which produce different effects, to ultimately determine their behavior. This paper analyzed the impact of the fairness preference of polluting enterprises on the design of government incentive mechanisms. The specific research conclusions are as follows. Through certain conditions and model assumptions, this paper obtains the incentive coefficient, effort level and speculation level both considering fairness preference and not considering fairness preference. After considering fairness preference, the reward coefficient and penalty coefficient will increase, the effort level will increase and the speculation level will decrease.

Government incentive mechanisms and supervision have an impact on the environmental responsibility of polluting enterprises. As an external factor, government subsidies and punishments are an important way to control the behavior of polluting enterprises. Excessive rewards and punishments will not only improve efficiency but also cause losses.

Therefore, it is necessary to carefully determine the degree of rewards and punishments. Government supervision will also incentivize polluting enterprises to assume environmental responsibility.

Fairness preference is the key internal factor that affects the environmental responsibility of polluting enterprises. The increase in fairness preference of polluting enterprises can improve the level of efforts of polluting enterprises and reduce the level of speculation of polluting enterprises. As the fairness preference of polluting enterprises increases, the optimal incentive subsidies and penalties will increase, and the expected returns of polluting enterprises and the government will also increase.

Based on the above findings, this paper is of great significance in promoting the environmental responsibility of polluting enterprises. At the same time, it introduces fairness preference into the incentive model, enriches the government's research on the incentive of polluting enterprises and provides a theoretical basis for different polluting enterprises to adopt differentiated incentive mechanisms. Based on the research conclusions, the following suggestions are put forward.

Develop differentiated policies according to local conditions. There are significant differences in economic development level, industrial structure and environmental carrying capacity in different regions. The government should formulate differentiated environmental governance policies according to regional characteristics. Economically developed regions (such as Germany and France in EU member states): Enterprises in these regions have strong economic strength and advanced environmental governance technology. The government should focus on promoting green technology innovation and industrial upgrading and encourage enterprises to bear environmental responsibility through market-oriented means such as carbon trading and green finance. Economically underdeveloped areas: The environmental governance capacity of enterprises in these areas is weak. The government should increase financial subsidies and technical support to help enterprises reduce the cost of governance and strictly enforce the law to prevent pollution transfer and diffusion. Strengthen the concept of environmental responsibility guidance. The government should guide polluting enterprises to establish the concept of environmental responsibility through various channels (such as publicity and education, policy interpretation, industry training, etc.) and encourage them to shift from passive compliance to actively taking environmental responsibility. At the same time, using the mechanism of public opinion, supervision and public participation, enterprises are encouraged to actively safeguard public environmental benefits and enhance their social image by publicizing environmental information and issuing social responsibility reports.

Differentiated supervision and incentive strategies. The government should implement differentiated supervision and incentive measures according to the scale, industry characteristics and environmental performance of polluting enterprises. For enterprises with high environmental governance costs, the government can reduce their governance costs by increasing economic subsidies (such as green credits, tax incentives, etc.), while strictly enforcing the law and imposing high penalties on illegal emission behaviors to form a mechanism of 'both incentives and constraints'. The government needs to divide the fairness preference of polluting enterprises, divide the fairness preference of polluting enterprises by analyzing the financial data and research reports of polluting enterprises and adopt different subsidy and punishment strategies for different levels of polluting enterprises.

The research in this paper has certain limitations. First of all, the research in this paper is based on both the government and the polluting enterprises, and less consideration is given to other external influencing factors. Secondly, the incentive mechanism of this study mainly focuses on rewards and punishments, and less consideration is given to

other incentive methods. Finally, this paper only designs the incentive coefficient at the macro-level. In the future, the design of incentive mechanisms can be verified and adjusted in combination with relevant polluting enterprises, and further research can be carried out at the micro-level.

Author Contributions: Conceptualization, G.J. and Q.W.; methodology, G.J.; software, Q.W.; validation, G.J. and Q.C.; formal analysis, Q.W. and Q.C.; investigation, G.J., Q.C. and Q.W.; resources, Q.C. and Q.W.; writing—original draft preparation, Q.C. and G.J.; writing—review and editing, G.J., Q.W. and Q.C.; visualization, Q.W.; supervision, G.J. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Natural Science Foundation of China (Grant No. 72162028) and the Inner Mongolia Autonomous Region directly under the University Research Fee Project, China (Grant No. JY20220143).

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Acknowledgments: Special thanks are given to those who participated in the writing of this paper.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Peng, B.; Chen, S.; Elahi, E.; Wan, A. Can corporate environmental responsibility improve environmental performance? An inter-temporal analysis of Chinese chemical companies. *Environ. Sci. Pollut. Res.* **2021**, *28*, 12190–12201. [CrossRef] [PubMed]
2. Tang, Y.; Yue, S.; Ma, W.; Zhang, L. How do environmental protection expenditure and green technology innovation affect synergistically the financial performance of heavy polluting enterprises? Evidence from China. *Environ. Sci. Pollut. Res.* **2022**, *29*, 89597–89613. [CrossRef] [PubMed]
3. Zhong, Z.; Peng, B. Can environmental regulation promote green innovation in heavily polluting enterprises? Empirical evidence from a quasi-natural experiment in China. *Sustain. Prod. Consum.* **2022**, *30*, 815–828. [CrossRef]
4. Zhao, X.-Z.; Chen, J.; Chen, F.-W.; Wang, W.; Xia, S. How high-polluting firms suffer from being distracted from intended purpose: A corporate social responsibility perspective. *Int. J. Environ. Res. Public Health* **2020**, *17*, 9197. [CrossRef] [PubMed]
5. European Commission. The European Green Deal. *Environ. Policy Clim. Change* **2019**. Available online: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en (accessed on 2 February 2025).
6. Godawska, J. Does environmental policy stringency matter for eco-innovation? Evidence from the EU countries. *Int. Entrep. Rev.* **2024**, *10*, 69–82. [CrossRef]
7. Huang, S.; Huat, K.T.; Liu, Y. Study on the influence of Chinese traditional culture on corporate environmental responsibility. *Math. Biosci. Eng.* **2023**, *20*, 14281–14305. [CrossRef]
8. Tan, X.; Li, S. Environmental responsibility information disclosure, cooperative resources, and enterprise market competitiveness. *Environ. Sci. Pollut. Res.* **2023**, *30*, 43331–43345. [CrossRef]
9. Du, L.; Wang, X.; Peng, J.; Jiang, G.; Deng, S. The impact of environmental information disclosure quality on green innovation of high-polluting enterprises. *Front. Psychol.* **2022**, *13*, 1069354. [CrossRef]
10. Shang, Y.; Chi, Y. Corporate environmental information disclosure and earnings management in China: Ethical behavior or opportunism motivation? *Sustainability* **2023**, *15*, 8896. [CrossRef]
11. Fan, L.; Yang, K.; Liu, L. New media environment, environmental information disclosure and firm valuation: Evidence from high-polluting enterprises in China. *J. Clean. Prod.* **2020**, *277*, 123253. [CrossRef]
12. Hu, S.; Zhang, C.; Ji, Y.; Zhang, C. Does environmental information disclosure tone affect corporate green innovation in China? Based on the institutional perspective. *Environ. Dev. Sustain.* **2023**, *26*, 12239–12282. [CrossRef]
13. Zhang, C.; Li, H.; Gou, X.; Feng, J.; Gao, X. CEO educational attainment, green innovation, and enterprise performance: Evidence from China's heavy-polluting enterprises. *Front. Environ. Sci.* **2022**, *10*, 1042400. [CrossRef]
14. Ang, R.; Shao, Z.; Liu, C.; Yang, C.; Zheng, Q. The relationship between CSR and financial performance and the moderating effect of ownership structure: Evidence from Chinese heavily polluting listed enterprises. *Sustain. Prod. Consum.* **2022**, *30*, 117–129. [CrossRef]
15. Dong, C.; He, J.; Du, L.; Yang, J. Executives with environmental experience and corporate environmental performance: Evidence from China's A-share listed companies. *Sustainability* **2023**, *15*, 15062. [CrossRef]

16. Wu, H.; Liao, W.; Zhou, Z.; Li, Y. Can financial constraints and regulatory distance reduce corporate environmental irresponsibility? *Sustainability* **2021**, *13*, 13243. [CrossRef]
17. Ma, X.; Ock, Y.-S.; Wu, F.; Zhang, Z. The effect of internal control on green innovation: Corporate environmental investment as a mediator. *Sustainability* **2022**, *14*, 1755. [CrossRef]
18. Zhu, N.; Zhang, Y. The impact of management's characteristics on corporate environmental responsibility performance of energy systems in the digital age—Evidence from China's traditional energy listed companies industry. *Energy Rep.* **2022**, *8*, 8821–8829. [CrossRef]
19. Xiong, G.; Luo, Y. Smog, media attention, and corporate social responsibility—Empirical evidence from Chinese polluting listed companies. *Environ. Sci. Pollut. Res.* **2021**, *28*, 46116–46129. [CrossRef]
20. Wu, Y.; Sun, H.; Sun, H.; Xie, C. Impact of public environmental concerns on the digital transformation of heavily polluting enterprises. *Int. J. Environ. Res. Public Health* **2023**, *20*, 203. [CrossRef]
21. Su, J.; Wei, Y.; Wang, S.; Liu, Q. The impact of digital transformation on the total factor productivity of heavily polluting enterprises. *Sci. Rep.* **2023**, *13*, 6386. [CrossRef]
22. Zheng, Y.; Zhang, Q. Digital transformation, corporate social responsibility and green technology innovation—Based on empirical evidence of listed companies in China. *J. Clean. Prod.* **2023**, *424*, 138805. [CrossRef]
23. Wu, T.; Wen, L.; Yi, M. Balancing growth targets and environmental regulations: An empirical analysis of dual policy impact on corporate environmental responsibility-insights from China. *J. Environ. Manag.* **2024**, *355*, 120500. [CrossRef] [PubMed]
24. Jiang, Y.; Qin, S.; Xu, Y. Impact of green credit policy on sustainability performance of high-pollution enterprises. *Environ. Sci. Pollut. Res.* **2022**, *29*, 79199–79213. [CrossRef]
25. Zeng, H.; Zhang, X.; Zhou, Q.; Jin, Y.; Cao, J. Tightening of environmental regulations and corporate environmental irresponsibility: A quasi-natural experiment. *Environ. Dev. Sustain.* **2022**, *24*, 13218–13259. [CrossRef]
26. Chen, M.; Su, Y.; Piao, Z.; Zhu, J.; Yue, X. The green innovation effect of urban energy saving construction: A quasi-natural experiment from new energy demonstration city policy. *J. Clean. Prod.* **2023**, *428*, 139392. [CrossRef]
27. Lu, J.; Li, H.; Yang, R. Effects of environmental liability insurance on illegal pollutant discharge of heavy polluting enterprises: Emission reduction incentives or pollution protector? *Socio-Econ. Plan. Sci.* **2024**, *92*, 101830. [CrossRef]
28. He, L.; Zhong, T.; Gan, S. Green finance and corporate environmental responsibility: Evidence from heavily polluting listed enterprises in China. *Environ. Sci. Pollut. Res.* **2022**, *29*, 74081–74096. [CrossRef]
29. Zheng, S.; Jin, S. Can enterprises in China achieve sustainable development through green investment? *Int. J. Environ. Res. Public Health* **2023**, *20*, 1787. [CrossRef]
30. Liang, X.; Li, S.; Luo, P.; Li, Z. Green mergers and acquisitions and green innovation: An empirical study on heavily polluting enterprises. *Environ. Sci. Pollut. Res.* **2022**, *29*, 48937–48952. [CrossRef]
31. Wang, W.; Wang, X. Does provincial green governance promote enterprise green investment? Based on the perspective of government vertical management. *J. Clean. Prod.* **2023**, *396*, 136519. [CrossRef]
32. Wu, J.; Chen, Z. The asymmetric influences of environmental subsidy and non-environmental subsidy on corporate environmental responsibility: Evidence from China. *Environ. Sci. Pollut. Res.* **2022**, *29*, 77057–77070. [CrossRef] [PubMed]
33. Zhao, Y.; Huang, Y.; Hu, S.; Sun, J. How tripartite stakeholders promote green technology innovation of China's heavily polluting enterprises? *Sustainability* **2023**, *15*, 9650. [CrossRef]
34. Teng, M.; Zhao, M.; Han, C.; Liu, P. A strategic analysis of incorporating corporate environmental responsibility into managerial incentive design: A differential game approach. *Environ. Sci. Pollut. Res.* **2023**, *30*, 30385–303407. [CrossRef] [PubMed]
35. Wang, L.; Pan, F. Incentive mechanism analysis of environmental governance using multitask principal–agent model. *Sustainability* **2023**, *15*, 4126. [CrossRef]
36. Shen, L.; Fan, R.; Wang, Y.; Cheng, E. Invisible economy, performance assessment of local governments, and environmental regulation in China. *Environ. Sci. Pollut. Res.* **2023**, 1–18. [CrossRef]
37. Wu, R.; Ling, S. The effect of the accountability system in promoting environmental conflict governance: An evolutionary game analysis. *Environ. Dev. Sustain.* **2023**, 1–30. [CrossRef]
38. Jiang, K.; You, D.; Merrill, R.; Li, Z. Implementation of a multi-agent environmental regulation strategy under Chinese fiscal decentralization: An evolutionary game theoretical approach. *J. Clean. Prod.* **2019**, *214*, 902–915. [CrossRef]
39. Xu, G.; Zhou, Y.; Zhou, Y. Research on the evolutionary mechanism and optimum control of pro-environmental behavior of polluting enterprises driven by environmental policies. *Environ. Dev. Sustain.* **2023**, *26*, 22085–22101. [CrossRef]
40. Huang, J.; Zheng, K.; Han, C. Green finance and enterprise green innovation: Incentive effect and synergy perspective. *Environ. Dev. Sustain.* **2023**, *26*, 28107–28129. [CrossRef]
41. Zhou, X.; Jia, M.; Wang, L.; Sharma, G.D.; Zhao, X.; Ma, X. Modelling and simulation of a four-group evolutionary game model for green innovation stakeholders: Contextual evidence in lens of sustainable development. *Renew. Energy* **2022**, *197*, 500–517. [CrossRef]

42. Lin, D.; Zhao, Y. The impact of environmental regulations on enterprises' green innovation: The mediating effect of managers' environmental awareness. *Sustainability* **2023**, *15*, 10906. [CrossRef]
43. Li, J.; Zhang, C.; Zhang, J.; Mi, Z.; Liu, Z.; Gong, L.; Lu, G. Incentive or constraint? Comprehensive impacts of green credit policy on industrial energy intensity. *Environ. Sci. Pollut. Res.* **2023**, *30*, 103101–103118. [CrossRef]
44. Ning, J.; Yuan, Z.; Shi, F.; Yin, S. Environmental pollution liability insurance and green innovation of enterprises: Incentive tools or self-interest means? *Front. Environ. Sci.* **2023**, *11*, 1077128. [CrossRef]
45. Nian, Z.; Bin, L.; Kun, W.; Wang, M. Game models for closed-supply chain with different competition-cooperation relationships under fairness preference. *Complexity* **2020**, *2020*, 6793216. [CrossRef]
46. Zhang, Z.J.; Wang, P.; Wan, M.Y.; Guo, J.H.; Luo, C.L. Interactive impacts of overconfidence and fairness concern on supply chain performance. *Adv. Prod. Eng. Manag.* **2020**, *15*, 277–294. [CrossRef]
47. Xu, D.; Liu, Q.; Jiang, X. The principal-agent model in venture investment based on fairness preference. *AIMS Math.* **2021**, *6*, 2171–2195. [CrossRef]
48. Wang, K.; Ding, C.; Chen, J.; Li, A. Venture investment incentive mechanisms and simulation with venture entrepreneurs having multistage efforts based on fairness preference theory. *Discret. Dyn. Nat. Soc.* **2016**, *2016*, 5862576. [CrossRef]
49. Yan, X.; Chong, H.; Zhou, J.; Sheng, Z.; Xu, F. Fairness preference based decision-making model for concession period in PPP projects. *J. Ind. Manag. Optim.* **2020**, *16*, 11–23. [CrossRef]
50. Han, J.; Jia, M.; Wu, G.; Yang, H. Strategic interaction between the government and the private sector in PPP projects incorporating the fairness preference. *IEEE Access* **2020**, *8*, 37621–37631. [CrossRef]
51. Wang, X.; Chen, X.; Zhou, H.; You, X. A study on the relationship between compensation gap within the top management team and corporate performance: An empirical research based on the moderation effect of fairness preference. *Front. Psychol.* **2022**, *13*, 916832. [CrossRef]
52. Lv, L.; Wang, Z.; Li, H.; Zhang, C.; Qiao, R. Tournament incentive mechanisms design for long-distance water diversion projects incorporating preference heterogeneity. *J. Constr. Eng. Manag.* **2022**, *148*, 04022036. [CrossRef]
53. Pan, L.; Liao, X.; Li, R.; Cao, S. The industrial decision analysis of regional coordinated development considering information distribution and fairness preference. *Sustainability* **2023**, *15*, 16006. [CrossRef]
54. Li, D.; Yang, L.; Liu, J.; Liu, H. Considering decoy effect and fairness preference: An incentive mechanism for crowdsensing. *IEEE Internet Things J.* **2019**, *6*, 8835–8852. [CrossRef]
55. Han, H.; Wang, Z.; Liu, B. Tournament incentive mechanisms based on fairness preference in large-scale water diversion projects. *J. Clean. Prod.* **2020**, *265*, 121861. [CrossRef]
56. Zhong, M.; Tan, N.; Chen, X. (Eds.) The design of sharing contract and the explanation of contract government paradox based on fairness preference. In Proceedings of the 2011 Fourth International Conference on Business Intelligence and Financial Engineering, Wuhan, China, 17–18 October 2011; IEEE: Piscataway, NJ, USA, 2011; pp. 17–18.
57. Chu, Y.; Cao, H. Study on the incentive mechanism of crowdsourcing considering participator's fairness preference. In Proceedings of the International Conference on Grey Systems and Intelligent Services (GSIS), Stockholm, Sweden, 8–11 August 2017; pp. 323–327.
58. Zhang, X.; Li, H. Reputation incentive model of open innovation of scientific and technological-based SMEs considering fairness preference. *Human. Soc. Sci. Commun.* **2023**, *10*, 941. [CrossRef]
59. Tan, R.; Hong, K. Research on extreme dispute decisions of large-scale engineering projects from the perspective of multidimensional preferences. *Mathematics* **2021**, *9*, 2940. [CrossRef]
60. Wang, L.; Tao, M.; An, X.; Dong, G. Research on profit-sharing mechanism of IPD projects considering multidimensional fairness preferences and BIM. *Systems* **2023**, *11*, 477. [CrossRef]
61. Lejarraga, T.; Hertwig, R. Three theories of choice and their psychology of losses. *Perspect. Psychol. Sci.* **2022**, *17*, 334–345. [CrossRef]
62. Zhang, Z.; Yang, C.; Li, W.; Yuan, J.; Yu, Z.; Wang, S. Fairness preference and performance optimization of e-commerce supply chain with private label. *Int. J. Prod. Econ.* **2023**, *246*, 37–48.
63. Wang, H.; Xu, S.; Liu, X.; Wu, G. Optimal contract design for cooperative supply chain based on fairness preference. *Sustainability* **2022**, *14*, 22.
64. Li, X.; Cao, G. Research of incentive mechanism based on fairness preference theory. *J. Ind. Eng. Eng. Manag.* **2008**, *22*, 107–111.
65. Pu, Y.; Guo, X.; Chen, Z.; Luo, X. Incentive mechanism for construction supply chain coordination under the influence of fairness preference. *Adv. Mech. Eng.* **2019**, *11*, 1687814019877022.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.