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Research Article

Incentive Contract Design considering Fairness Preferences and Carbon Emission Reduction Multiobjective Tasks

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Considering the multitargets of corporate carbon emission reduction and the fairness preference psychology of the company, a government incentive model for corporate carbon emission reduction was constructed. The impact of corporate fairness preferences on government carbon emission reduction incentive strategies is studied. In addition, numerical simulation is used to analyze the impact of changes in correlation coefficients, fairness preference coefficients, and discount rates on the optimal enterprise effort coefficient and the government optimal incentive coefficient. Research shows that the degree of fairness preference of a company has a direct impact on the degree of corporate effort, while the discount rate will only have an impact on the company's long-term effort. In order to improve corporate carbon emission reduction efforts, the government must not only consider the impact of fairness preference on corporate efforts but also flexibly adjust the incentive coefficient of long-term and short-term tasks based on the discount rate.

1. Introduction

The rapid development of the global economy has brought about huge energy consumption and also led to an unprecedented increase in greenhouse gas emissions. In order to control carbon emissions and achieve sustainable economic development, international agreements such as the Paris Agreement and the Kyoto Protocol have been signed successively and have gained more and more recognition around the world. The participating countries actively set carbon emission reduction targets based on their national conditions, and all countries experience significant pressure to reduce their carbon emissions.

In the process of carbon emission reduction, the government can generally adopt incentive policies and restrictive policies [1]. Incentive policies refer to the positive guidance of low-carbon behaviors of enterprises through low-carbon subsidies. Restrictive policies refer to restricting disciplinary measures to reduce corporate carbon emissions such as carbon taxes and carbon emission quotas [2]. At present, most countries implement carbon emission quotas and carbon trading to achieve their regional carbon emission reduction targets. However, there are many problems in the operation of carbon trading mechanism. First, the total quotas for carbon emission reductions are too loose, leading to a sharp decline in the price of carbon trading; Secondly, because the redistribution of carbon allowances is based on the previous year's emissions, companies pay more attention to the short-term performance of carbon emissions reductions and are unwilling to achieve long-term emission reductions through scientific research and development. Compared with restrictive policies, incentive policies can better coordinate the short-term and long-term goals of carbon emission reduction and are generally easier to accept by companies, so that corporate carbon emissions can achieve sustainability. Therefore, discussing how government agencies can reasonably design incentive mechanisms to encourage companies to imply carbon emission reductions is a very practical issue.

The literature related to this study is divided into two parts: (1) carbon taxes and cap-and-trade schemes; (2) low-carbon technology subsidies and incentives. Carbon taxes and cap-and-trade schemes are a significant topic in academic area. Most studies on carbon emissions involve a carbon tax mechanism or a cap-and-trade mechanism [3, 4]. Hoel and Karp [5] believe that carbon tax, as a policy to regulate national development, can guide companies to adopt environmentally friendly raw materials and reduce the impact of industrial development on climate change. Some scholars have used corporate data from different industries to verify the impact of carbon tax policies on corporate carbon emissions reduction [6, 7]. The implementation of the carbon tax and carbon trading system provides a way to reduce carbon emissions, but the effect seems to be suboptimal. The poor progress of the Kyoto Protocol and the sharp drop in carbon prices indicate that the current carbon trading system still has shortcomings [8].

The literature shows that although the carbon tax policy can bring more sufficient tax revenue to the government, it will also passively increase the cost pressure of enterprises. In order to enable companies to take the initiative to reduce carbon emissions and develop low-carbon energy technologies, scholars have proposed methods of low-carbon technology subsidies in addition to the carbon tax policy. Galinato and Yoder [9] comparatively analyze the impact of low-carbon energy subsidy policies and carbon tax policies on corporate carbon emission reduction and social welfare benefits. In the study of Jotzo and Pezzey [10], according to the expected GDP growth in different regions, a model of government low-carbon technology subsidies linked to GDP has been established. Part of the literature uses real corporate data and cases to verify the incentives of local officials' characteristics and government low-carbon technology subsidies for regional carbon emission reduction [11, 12].

In the literature on low-carbon subsidy incentive mechanisms, scholars focus on the design of incentive contracts. Eichner and Pethig [13] constructed an incentive contract model to explore the impact of national green energy subsidies on the development of low-carbon technologies for enterprises. Liu and Sun [14], based on the rank-order tournament mechanism model, established a long-term mechanism model for the government to encourage enterprises for low-carbon development. On the basis of considering the intensity of corporate carbon emissions and cooperative game theory, Wang et al. [15] constructed a government-to-business incentive contract and used real data from 16 textile companies to verify the effectiveness of the model. Qiu et al. [16, 17] studied the issue of carbon tax incentive policies for airline passenger transportation, and the research showed that the government promotes airlines to improve fuel consumption and emission performance through competitive tax rebates. In addition, some scholars have analyzed the role of low-carbon technology subsidies in promoting technology research of companies based on the perspective of supply chain [3, 4, 18, 19].

In summary, the existing literature has studied the government's strategies to limit corporate carbon emissions reduction from multiple perspectives such as carbon tax, carbon trading, and low-carbon subsidies. However, there is still a lack of literature on the government's incentive contract for corporate carbon emission reduction. In addition, most of the relevant literature does not consider the multitarget of carbon emission reduction tasks or the fair preference of enterprises when constructing the government's carbon emission reduction incentive contract for enterprises. Therefore, the focus of this paper will mainly focus on the following two aspects:

(1) Dividing the carbon emission reduction tasks of enterprises into long-term tasks and short-term tasks based on literature data, considering the discounted value of long-term task performance, and constructing a government-to-enterprise carbon emission reduction multiobjective incentive contract.

(2) Most of the literature assumes that participating companies are completely rational, ignoring the influence of fairness preference psychology on the behavior of participating enterprises. This article will consider the influence of fairness preference psychology on the incentive effect of enterprises and analyze the government's optimal incentive strategy under different fairness preference of enterprises.

This remainder of this paper is structured as follows. Section 2 reviews the definition of fairness preference in the classic literature and analyzes the main measures commonly used by companies to reduce carbon emissions. Based on this, four assumptions for model construction are put forward, which provides a prerequisite for the construction of incentive contracts. Section 3 builds a fully rational government-to-corporate multiobjective incentive contract model for carbon emission reduction and analyzes the government's optimal incentive strategy considering the long-term performance of carbon emission reduction. Section 4 constructs the government-to-corporate multiobjective incentive contract under jealous preference and sympathy preference and analyzes the influence of different fairness preferences on government incentive strategies. Section 5 shows the influence of different parameter changes on the optimal strategy of incentive contract through numerical analysis. Section 6 offers conclusions and management implications.

2. Model Preliminaries

The academic community has conducted a detailed analysis of the corporate carbon emission reduction tasks, and the literature shows that the corporate carbon emission reduction tasks can be divided into three categories: The first is system management, which raises workers' awareness of carbon emission reduction through the development of management systems and changes workers' original resource waste habits. The second is clean energy, which is achieved by adopting low-carbon energy and replacing energy-consuming equipment. The third is low-carbon technology, through the development of new technologies, new equipment, and new products to improve energy efficiency and reduce energy consumption. Among them, the carbon emission reduction performance achieved by replacing the management system and clean energy can be judged by observing the company's carbon emission performance in the short term. However, to improve the low-carbon technology of enterprises, long-term accumulation of enterprise research and development is required, and the long-term performance of enterprise carbon emissions is used to demonstrate the development of low-carbon technology. Therefore, it will be more in line with the reality of sustainable development to provide corresponding incentives by distinguishing the short-term and long-term tasks of enterprises to achieve carbon emission reduction [20, 21].

This article analyzes the income distribution as the external source of perception of the agent's fairness preference. The agent's concern for the fairness of income distribution means that he not only cares about his own income but also pays attention to the income of others, and the income gap affects the actual income level of people through their own likes or dislikes. When constructing an incentive contract model based on fairness preference, this article draws on the fairness preference theory proposed by Fehr and Schmidt [22] and Bolton and Ockenfels [23]. This article mainly considers the fairness preference among enterprises. There is a fair subsidy accepted by the enterprise. When the benefit of participating in carbon emission reduction is lower than the fair subsidy, the participating enterprises will have the negative effect of jealous preference; when the benefit of participating in carbon emission reduction is higher than the fair subsidy, the participating companies will have the negative effect of sympathy and preference. The final deterministic equivalent income obtained under the fair preference of the enterprise is

$$E(\pi_E)_1 = E(\pi_E) - k_1 \max[F - S(\pi), 0] - k_2 \max[S(\pi) - F, 0]. \tag{1}$$

k_1 and k_2 are the jealous preference coefficient and sympathy preference coefficient of the enterprise, respectively, and F represents the fair subsidy accepted by the enterprise $0 \le k_1 < k_2 \le 1$ [24]. When k_1 and k_2 are smaller, the fairness preference characteristic of the company is smaller. In the best case, when $k = 0$, it means that the company has received absolutely fair subsidies for participating in carbon emission reduction. However, the reality is that due to the inconsistency of carbon emission reduction policies in various regions, coupled with factors such as human operations, it is difficult for companies to achieve absolute fairness in subsidies for carbon emission reduction. For the convenience of research, this paper defines the situation that the subsidy of carbon emission reduction income of enterprises is lower than the fair subsidy as the unfair disadvantage, and the situation that the subsidy of carbon emission reduction income of enterprises is higher than the fair subsidy as the unfair advantage. This paper discusses the incentive contract design in these two cases.

In this paper, we make the following assumptions when constructing the incentive contract of long-term and short-term performance of carbon emission reduction under fair preference:

Assumption 1. The government and enterprises are independent of each other, and both of them take their own profit maximization as their decision-making goal in the decision-making process. The government is risk neutral and the enterprise is risk averse, which has the characteristics of absolute risk aversion, meeting $\mu(x) = -\exp(-\rho x)$. ρ is the amount of absolute risk aversion, and x is the actual monetized income of the enterprise after carbon emission reduction [25].

Assumption 2. The degree of enterprise carbon emission reduction efforts cannot be observed, but it can be confirmed by observing the long-term and short-term performance of enterprise carbon emission reduction. The short-term performance of enterprises after implementing carbon emission reduction efforts is $\pi(e_1) = e_1 + \theta_1$, e_1 is the effort degree of enterprises to achieve the short-term performance goal of carbon emission reduction, and θ_1 is the exogenous random variable; at the same time, the long-term performance of enterprises after implementing carbon emission reduction efforts is $\pi(e_2) = re_2 + \theta_2$, e_2 is the effort degree of enterprises to achieve the long-term performance goal of carbon emission reduction, r is the discount rate $(0 < r < 1)$, it means that the long-term performance of carbon emission reduction is affected by the discount rate, and θ_2 is an exogenous random variable. Therefore, $\pi(e) = e_1 + \theta_1 + re_2 + \theta_2$ is the total performance of enterprises after implementing carbon emission reduction efforts, which is the sum of short-term and long-term performance [26]. θ_1 and θ_2 are not related to each other and meet the requirements of $\theta_1 \sim N(0, \sigma_1^2)$ and $\theta_2 \sim N(0, \sigma_2^2)$, respectively.

Assumption 3. In the process of carbon emission reduction, the enterprise produces the corresponding effort cost $C(e_1, e_2) = (e_1^2/2) + (e_2^2/2) + \varphi e_1 e_2$, where $-1 \le \varphi \le 1$ is the correlation coefficient of the two tasks [27]. When the two tasks promote each other, $-1 \le \varphi < 0$ is satisfied; when the two tasks hinder each other, $0 < \varphi \le 1$ is satisfied; when the two tasks are irrelevant, $\varphi = 0$ is satisfied. In general, the short-term task and long-term task of enterprise carbon emission reduction will promote each other, so set $-1 \le \varphi < 0$.

Assumption 4. Linear contract is the optimal contract design method [26], so it is assumed that the incentive contract of carbon emission reduction given by the government to enterprises is designed as

$$S(\pi) = \alpha + \beta_1 \pi(e_1) + \beta_2 \pi(e_1). \tag{2}$$

α is the fixed subsidy given by the government to enterprises, β_1 and β_2 are the incentive coefficients of short-term carbon emission reduction and long-term carbon emission reduction, respectively, and $0 \le \beta_1, \beta_2 \le 1$.

In the paper, let $E(\pi_i)_j$ $(i = G, E,\ j = r, j, c)$ denote the return function of government $(i = G)$ and enterprise $(i = E)$ under complete rationality $(j = r)$, jealousy preference

($j = j$), and sympathy preference ($j = c$). And some other symbols used in this study are summarized in Table 1.

3. Incentive Contract Design under Complete Rationality

Under the condition of complete rationality, the firm's deterministic equivalent income is

$$E(\pi_E)_r = S(\pi) - C(e_{r1}, e_{r2}) - \frac{1}{2}\rho\left(\sigma_1^2\beta_{r1}^2 + \sigma_2^2\beta_{r2}^2\right). \quad (3)$$

At the same time, the expected return function of the government can be obtained:

$$E(\pi_G)_r = (1-\beta_{r1})e_{r1} + (1-\beta_{r2})re_{r2} - \alpha. \quad (4)$$

When the government carries out the carbon emission reduction incentive contract, the goal is to maximize its expected income, namely,

$$\max E(\pi_G)_r = (1-\beta_{r1})e_{r1} + (1-\beta_{r2})re_{r2} - \alpha. \quad (5)$$

In order to enable enterprises to participate in carbon emission reduction, they must also meet the constraints of participation, and the expected income of enterprises participating in carbon emission reduction should not be less than their retained income level:

$$E(\pi_E)_r \geq W_0. \quad (6)$$

Due to the information asymmetry between the government and enterprises, the government cannot observe the enterprise's carbon emission reduction efforts and cannot judge the extent of their efforts, so it is necessary to encourage enterprises to strive to implement carbon emission reduction through incentive contracts. If we want to encourage enterprises to actively control carbon emission reduction, we must make enterprises choose the appropriate level of effort according to their expected utility maximization:

$$e_{r1}, e_{r2} \in \arg\max\left(E(\pi_E)_r\right). \quad (7)$$

To sum up, the incentive contract model of long-term and short-term carbon reduction tasks of enterprises considering the fairness preference of the government is as follows:

$$\begin{cases} \max & E(\pi_G)_r = (1-\beta_{r1})e_{r1} + (1-\beta_{r2})re_{r2} - \alpha \\ \text{s.t.} & (IR)E(\pi_E)_r \geq W_0 \\ & (IC)e_{r1}, e_{r2} \in \arg\max E(\pi_E)_r. \end{cases} \quad (8)$$

Table 1: Introduction of the symbol.

Symbol	Symbolic meaning
ρ	The amount of absolute risk aversion
φ	The correlation coefficient of the two tasks
r	The discount rate
α	The fixed subsidy given by the government
e_1	Short-term efforts of the enterprise
e_2	Long-term efforts of the enterprise
β_1	Short-term incentive coefficient of the government
β_2	Long-term incentive coefficient of the government

By deriving the constraints of formula (8) to e_{r1} and e_{r2}, the effort degree of carbon emission reduction enterprises can be expressed as follows:

$$\begin{aligned} e_{r1} &= \frac{\beta_{r1} - \varphi r\beta_{r2}}{1-\varphi^2}, \\ e_{r2} &= \frac{r\beta_{r2} - \varphi\beta_{r1}}{1-\varphi^2}. \end{aligned} \quad (9)$$

For the government, in order to ensure that enterprises participate in carbon emission reduction, the financial subsidy paid to enterprises is equal to the retained income of enterprises, and it is unnecessary to pay higher financial subsidies. Therefore, let formula (6) be equal:

$$\begin{aligned} &\alpha + \beta_{r1}e_{r1} + r\beta_{r2}e_{r2} - \frac{e_{r1}^2}{2} - \frac{e_{r2}^2}{2} - \varphi e_{r1}e_{r2} \\ &- \frac{1}{2}\rho\left(\sigma_1^2\beta_{r1}^2 + \sigma_2^2\beta_{r2}^2\right) = W_0. \end{aligned} \quad (10)$$

After substituting formula (10) into the objective function, it is obtained that

$$\begin{aligned} \max E(\pi_G) = e_{r1} + re_{r2} - \frac{e_{r1}^2}{2} - \frac{e_{r2}^2}{2} - \varphi e_{r1}e_{r2} \\ - \frac{1}{2}\rho\left(\sigma_1^2\beta_{r1}^2 + \sigma_2^2\beta_{r2}^2\right) - W_0. \end{aligned} \quad (11)$$

After substituting e_{r1} and e_{r2} into formula (12), the following equivalent problems are obtained:

$$\begin{aligned} \max E(\pi_G)_r = \frac{\beta_{r1} - \varphi r\beta_{r2}}{1-\varphi^2} + r\frac{r\beta_{r2} - \varphi\beta_{r1}}{1-\varphi^2} - \frac{\left(\beta_{r1} - \varphi r\beta_{r2}/1-\varphi^2\right)^2}{2} \\ - \frac{\left(r\beta_{r2} - \varphi\beta_{r1}/1-\varphi^2\right)^2}{2} - \varphi\left(\frac{\beta_{r1} - \varphi r\beta_{r2}}{1-\varphi^2}\right)\left(\frac{r\beta_{r2} - \varphi\beta_{r1}}{1-\varphi^2}\right) - \frac{1}{2}\rho\left(\sigma_1^2\beta_{r1}^2 + \sigma_2^2\beta_{r2}^2\right) - W_0. \end{aligned} \quad (12)$$

Then, by deriving β_{r1} and β_{r2} and making their reciprocal 0, the optimal excitation functions are obtained as follows:

$$\beta_{r1} = \frac{r^2 + (1-\varphi r)\rho\sigma_2^2}{r^2 + \rho\sigma_2^2 + \rho\sigma_1^2 r^2 + \rho^2\sigma_1^2\sigma_2^2\left(1-\varphi^2\right)}, \tag{13}$$

$$\beta_{r2} = \frac{r^2 + \left(r^2 - \varphi r\right)\rho\sigma_1^2}{r^2 + \rho\sigma_2^2 + \rho\sigma_1^2 r^2 + \rho^2\sigma_1^2\sigma_2^2\left(1-\varphi^2\right)}. \tag{14}$$

After substituting formulae (13) and (14) into formula (9), we can obtain the optimal effort degree of the enterprise, which is as follows:

$$\begin{aligned} e_{r1} &= \frac{r^2 - \varphi r^3 + (1-\varphi r)\rho\sigma_2^2 - \left(\varphi r^3 - \varphi^2 r^2\right)\rho\sigma_1^2}{\left(1-\varphi^2\right)\left(r^2 + \rho\sigma_2^2 + \rho\sigma_1^2 r^2 + \rho^2\sigma_1^2\sigma_2^2\left(1-\varphi^2\right)\right)}, \\ e_{r2} &= \frac{r^3 - \varphi r^2 + \left(r^3 - \varphi r^2\right)\rho\sigma_1^2 - \left(\varphi - \varphi^2 r\right)\rho\sigma_2^2}{\left(1-\varphi^2\right)\left(r^2 + \rho\sigma_2^2 + \rho\sigma_1^2 r^2 + \rho^2\sigma_1^2\sigma_2^2\left(1-\varphi^2\right)\right)}. \end{aligned} \tag{15}$$

4. Incentive Contract Design under Fairness Preference

4.1. Incentive Contract under Unfair Disadvantage. In the case of unfair disadvantage, the subsidy of carbon emission reduction income is lower than that of fair subsidy, which satisfies $F > S(\pi)$, and the deterministic equivalent income of carbon emission reduction is as follows:

$$\begin{aligned} E\left(\pi_E\right)_j &= S(\pi) - C\left(e_{j1}, e_{j2}\right) - \frac{1}{2}\rho\beta_{j1}^2\sigma_1^2 - \frac{1}{2}\rho\beta_{j2}^2\sigma_2^2 - k_1\left(F - S(\pi)\right) \\ &= \left(1+k_1\right)\alpha + \left(1+k_1\right)\beta_{j1}e_{j1} + \left(1+k_1\right)r\beta_{j2}e_{j2} - \frac{e_{j1}^2}{2} - \frac{e_{j2}^2}{2} - \varphi e_{j1}e_{j2} - \frac{1}{2}\rho\left(\beta_{j1}^2\sigma_1^2 + \beta_{j2}^2\sigma_2^2\right) - k_1 F. \end{aligned} \tag{16}$$

The incentive contract model of long-term and short-term carbon emission reduction performance of enterprises considering fairness preference is as follows:

$$\begin{cases} \max & E\left(\pi_G\right)_j = \left(1-\beta_{j1}\right)e_{j1} + \left(1-\beta_{j2}\right)re_{j2} - \alpha \\ & (IR) E\left(\pi_E\right)_j \geq W_0 \\ \text{s.t.} & \\ & (IC) e_{j1}, e_{j2} \in \arg\max E\left(\pi_E\right)_j. \end{cases} \tag{17}$$

After obtaining the first derivative of the constraint conditions in formula (17) for e_{j1} and e_{j2}, respectively, and making the reciprocal equal to 0, the expression of enterprise effort degree can be obtained as follows:

$$\begin{aligned} e_{j1} &= \frac{\left(1+k_1\right)\left(\beta_{j1} - \varphi r\beta_{j2}\right)}{1-\varphi^2}, \\ e_{j2} &= \frac{\left(1+k_1\right)\left(r\beta_{j2} - \varphi\beta_{j1}\right)}{1-\varphi^2}. \end{aligned} \tag{18}$$

After substituting e_{j1} and e_{j2}, the following equivalent problems are obtained:

$$\begin{aligned} \max E\left(\pi_G\right)_j = {} & \left(1+k_1\right)\left[\frac{\left(\beta_{j1} - \varphi r\beta_{j2}\right)}{1-\varphi^2} + r\frac{\left(r\beta_{j2} - \varphi\beta_{j1}\right)}{1-\varphi^2}\right] - \frac{\left(\left(1+k_1\right)\left(\beta_{j1} - \varphi r\beta_{j2}\right)/1-\varphi^2\right)^2}{2} \\ & - \frac{\left(\left(1+k_1\right)\left(r\beta_{j2} - \varphi\beta_{j1}\right)/1-\varphi^2\right)^2}{2} - \varphi\left(1+k_1\right)^2\left(\frac{\left(\beta_{j1} - \varphi r\beta_{j2}\right)}{1-\varphi^2}\right)\left(\frac{\left(r\beta_{j2} - \varphi\beta_{j1}\right)}{1-\varphi^2}\right) \\ & - \frac{1}{2}\rho\left(\beta_{j1}^2\sigma_1^2 + \beta_{j2}^2\sigma_2^2\right) - W_0. \end{aligned} \tag{19}$$

Then, let formula (19) obtain the first-order derivative for β_{j1} and β_{j2}, and make the first derivative equal to 0, and the optimal excitation functions are obtained, respectively:

$$\beta_{j1} = \frac{(1+k_1)^3 r^2 + (1+k_1)(1-\varphi r)\rho\sigma_2^2}{r^2(1+k_1)^4 + \rho\sigma_2^2(1+k_1)^2 + \rho\sigma_1^2 r^2(1+k_1)^2 + \rho^2\sigma_1^2\sigma_2^2(1-\varphi^2)}, \tag{20}$$

$$\beta_{j2} = \frac{(1+k_1)^3 r^2 + (1+k_1)(r^2-\varphi r)\rho\sigma_1^2}{r^2(1+k_1)^4 + \rho\sigma_2^2(1+k_1)^2 + \rho\sigma_1^2 r^2(1+k_1)^2 + \rho^2\sigma_1^2\sigma_2^2(1-\varphi^2)}. \tag{21}$$

After substituting formulae (20) and (21) into formula (19), the optimal effort degree of enterprises can be obtained as follows:

$$\begin{aligned} e_{j1} &= \frac{(1+k_1)^4(r^2-\varphi r^3) + (1+k_1)^2\left[(1-\varphi r)\rho\sigma_2^2 - (\varphi r^3 - \varphi^2 r^2)\rho\sigma_1^2\right]}{(1-\varphi^2)\left(r^2(1+k_1)^4 + \rho\sigma_2^2(1+k_1)^2 + \rho\sigma_1^2 r^2(1+k_1)^2 + \rho^2\sigma_1^2\sigma_2^2(1-\varphi^2)\right)}, \\ e_{j2} &= \frac{(1+k_1)^4(r^3-\varphi r^2) + (1+k_1)^2\left[(r^3-\varphi r^2)\rho\sigma_1^2 - (\varphi - \varphi^2 r)\rho\sigma_2^2\right]}{(1-\varphi^2)\left(r^2(1+k_1)^4 + \rho\sigma_2^2(1+k_1)^2 + \rho\sigma_1^2 r^2(1+k_1)^2 + \rho^2\sigma_1^2\sigma_2^2(1-\varphi^2)\right)}. \end{aligned} \tag{22}$$

4.2. Incentive Contract under Unfair Advantage. In the case of unfair disadvantage, the subsidy of carbon emission reduction income is higher than that of fair subsidy, which satisfies $F < S(\pi)$, and the deterministic equivalent income of carbon emission reduction is as follows:

$$\begin{aligned} E(\pi_E)_c &= S(\pi) - C(e_{c1}, e_{c2}) - \frac{1}{2}\rho\left(\beta_{c1}^2 + \beta_{c2}^2\right)\sigma^2 - k_2(S(\pi) - F) \\ &= (1-k_2)\alpha + (1-k_2)\beta_{c1}e_{c1} + (1-k_2)r\beta_{c2}e_{c2} - \frac{e_{c1}^2}{2} - \frac{e_{c2}^2}{2} - \varphi e_{c1}e_{c2} - \frac{1}{2}\rho\left(\beta_{c1}^2\sigma_1^2 + \beta_{c2}^2\sigma_2^2\right) + k_1 F. \end{aligned} \tag{23}$$

Therefore, the incentive contract model of long-term and short-term carbon emission reduction performance considering fairness preference of government is as follows:

$$\begin{cases} \max & E(\pi_G)_c = (1-\beta_{c1})e_{c1} + (1-\beta_{c2})re_{c2} - \alpha \\ \text{s.t.} & (IR)E(\pi_E)_c \geq W_0 \\ & (IC)e_{c1}, e_{c2} \in \arg\max E(\pi_E)_c. \end{cases} \tag{24}$$

After obtaining the first derivative of the constraint conditions in formula (24) for e_{c1} and e_{c2}, respectively, and making the reciprocal equal to 0, the expression of enterprise effort degree can be obtained as follows:

$$\begin{aligned} e_{c1} &= \frac{(1-k_2)(\beta_{c1} - \varphi r\beta_{c2})}{1-\varphi^2}, \\ e_{c2} &= \frac{(1-k_2)(r\beta_{c2} - \varphi\beta_{c1})}{1-\varphi^2}. \end{aligned} \tag{25}$$

After substituting e_{c1} and e_{c2}, the following equivalent problems are obtained:

$$\max E\left(\pi_G\right)_c = \left(1-k_2\right)\left[\frac{\left(\beta_{c1}-\varphi r\beta_{c2}\right)}{1-\varphi^2}+r\frac{\left(r\beta_{c2}-\varphi\beta_{c1}\right)}{1-\varphi^2}\right]-\frac{\left(\left(1-k_2\right)\left(\beta_{c1}-\varphi r\beta_{c2}\right)/1-\varphi^2\right)^2}{2}$$
$$-\frac{\left(\left(1-k_2\right)\left(r\beta_{c2}-\varphi\beta_{c1}\right)/1-\varphi^2\right)^2}{2}-\varphi\left(1-k_2\right)^2\left(\frac{\left(\beta_{c1}-\varphi r\beta_{c2}\right)}{1-\varphi^2}\right)\left(\frac{\left(r\beta_{c2}-\varphi\beta_{c1}\right)}{1-\varphi^2}\right)-\frac{1}{2}\rho\left(\beta_{c1}^2\sigma_1^2+\beta_{c2}^2\sigma_2^2\right)-W_0. \tag{26}$$

Then, let formula (26) obtain the first-order derivative for β_{c1} and β_{c2}, and make the first derivative equal to 0, and the optimal excitation functions are obtained, respectively:

$$\beta_{c1} = \frac{\left(1-k_2\right)^3 r^2+\left(1-k_2\right)\left(1-\varphi r\right)\rho\sigma_2^2}{r^2\left(1-k_2\right)^4+\rho\sigma_2^2\left(1-k_2\right)^2+\rho\sigma_1^2 r^2\left(1-k_2\right)^2+\rho^2\sigma_1^2\sigma_2^2\left(1-\varphi^2\right)}, \tag{27}$$

$$\beta_{c2} = \frac{\left(1-k_2\right)^3 r^2+\left(1-k_2\right)\left(r^2-\varphi r\right)\rho\sigma_1^2}{r^2\left(1-k_2\right)^4+\rho\sigma_2^2\left(1-k_2\right)^2+\rho\sigma_1^2 r^2\left(1-k_2\right)^2+\rho^2\sigma_1^2\sigma_2^2\left(1-\varphi^2\right)}. \tag{28}$$

After substituting formulae (27) and (28) into formula (26), the optimal effort degree of enterprises can be obtained as follows:

$$\begin{aligned} e_{c1} &= \frac{\left(1-k_2\right)^4\left(r^2-\varphi r^3\right)+\left(1-k_2\right)^2\left[\left(1-\varphi r\right)\rho\sigma_2^2-\left(\varphi r^3-\varphi^2 r^2\right)\rho\sigma_1^2\right]}{\left(1-\varphi^2\right)\left(r^2\left(1-k_2\right)^4+\rho\sigma_2^2\left(1-k_2\right)^2+\rho\sigma_1^2 r^2\left(1-k_2\right)^2+\rho^2\sigma_1^2\sigma_2^2\left(1-\varphi^2\right)\right)},\\ e_{c2} &= \frac{\left(1-k_2\right)^4\left(r^3-\varphi r^2\right)+\left(1-k_2\right)^2\left[\left(r^3-\varphi r^2\right)\rho\sigma_1^2-\left(\varphi-\varphi^2 r\right)\rho\sigma_2^2\right]}{\left(1-\varphi^2\right)\left(r^2\left(1-k_2\right)^4+\rho\sigma_2^2\left(1-k_2\right)^2+\rho\sigma_1^2 r^2\left(1-k_2\right)^2+\rho^2\sigma_1^2\sigma_2^2\left(1-\varphi^2\right)\right)}. \end{aligned} \tag{29}$$

5. Numerical Analysis

In this section, MATLAB software is used to expand the numerical simulation analysis. By analyzing the changes in the correlation coefficient, jealous preference coefficient, sympathy preference coefficient, discount rate, and other parameters, the effect of each parameter change on the government's optimal incentives for enterprises and enterprises' optimal efforts is studied. First of all, refer to the existing literature [28], and the parameters in the previous paper are assigned: let $r = 0.8$, $\rho = 1$, $\sigma_1 = 3$, $\sigma_2 = 1.5$, $\varphi = -0.5$, $k_1 = 0.6$, and $k_2 = 0.3$.

5.1. Analysis of the Influence of Long-Term and Short-Term Task Correlation Coefficient on Incentive Coefficient and Enterprise Effort. Figures 1 and 2, respectively, show the influence of long-term and short-term task correlation coefficient on government incentive coefficient and enterprise effort. As can be seen from Figures 1 and 2, with the increasing of the correlation coefficient of long-term and short-term tasks, the government incentive coefficient and the optimal effort degree of enterprises in the three cases are decreasing. The correlation coefficient of long-term and short-term tasks essentially indicates the task resistance when enterprises carry out long-term and short-term tasks at the same time. The smaller the correlation coefficient is, the greater the correlation of long-term and short-term tasks is, and the smaller the task resistance when enterprises carry out long-term and short-term tasks at the same time. Therefore, the optimal incentive coefficient of the government and the optimal effort degree of enterprises will increase accordingly.

5.2. Analysis of the Influence of Jealousy Preference on Incentive Coefficient and Enterprise Efforts. Figures 3 and 4, respectively, show the influence of jealousy preference coefficient on incentive coefficient and enterprise effort. It can be seen from Figures 3 and 4 that with the increasing of jealousy preference coefficient of enterprises, the government's short-term task incentive coefficient and the enterprise's optimal effort degree are increasing; the government's long-term task incentive coefficient first increases and then decreases. With

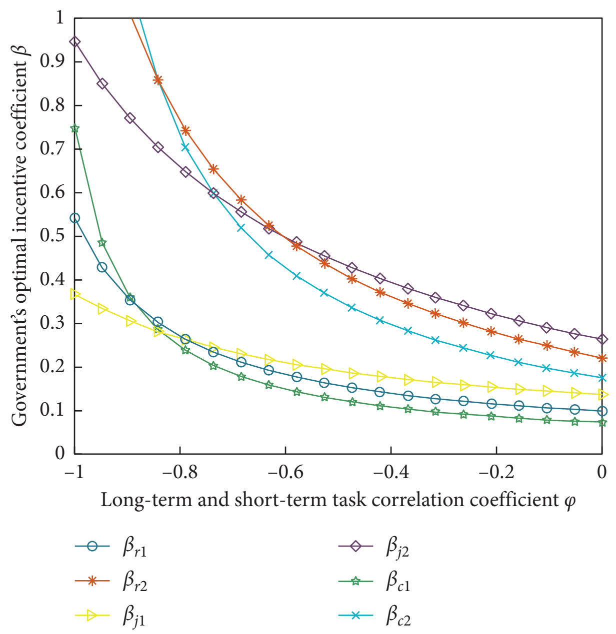

Figure 1: Government incentive coefficients under different φ.

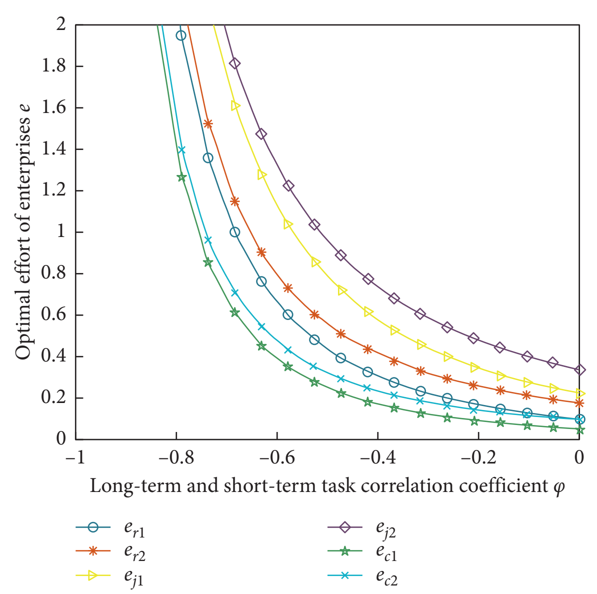

Figure 2: Corporate efforts under different φ.

the increase of jealousy preference coefficient, the government needs to increase subsidies to reduce the negative effect of jealousy preference. With the increase of government incentive coefficient, the optimal carbon effort of enterprises will also increase.

5.3. Analysis of the Influence of Sympathy Preference on Incentive Coefficient and Enterprise Efforts. Figures 5 and 6 show the influence of sympathy preference coefficient on government incentive coefficient and enterprise effort level, respectively. From Figures 5 and 6, it can be seen that with the increase of the coefficient of corporate sympathy

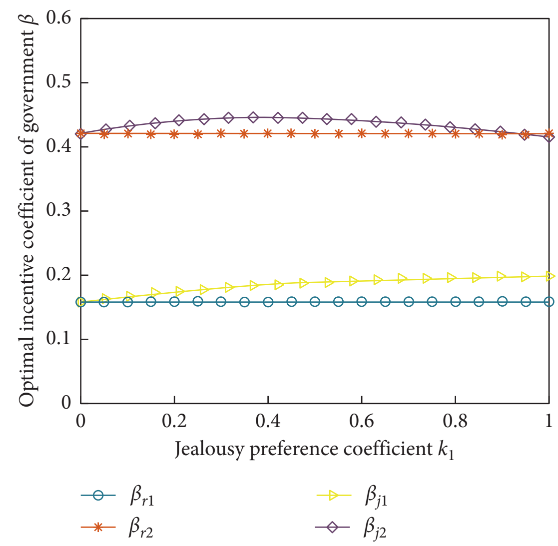

Figure 3: Government incentive coefficients under different k_1.

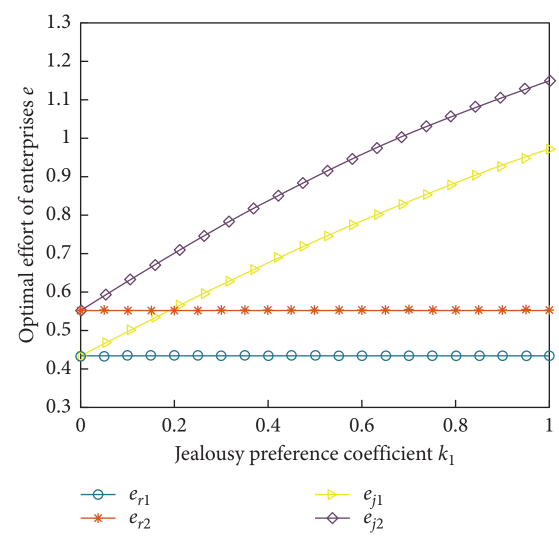

Figure 4: Corporate efforts under different k_1.

preference, the government incentive coefficient and the enterprise effort degree are decreasing. With the increase of the coefficient of corporate sympathy preference, the government needs to reduce subsidies to alleviate the negative utility of corporate compassion preference, so the optimal effort of enterprises will also decrease. When the government provides incentive subsidies for carbon emission reduction, it needs to take into account the jealousy preference and sympathy preference of enterprises at the same time, so as to achieve fairness and justice as far as possible in order to produce the optimal incentive effect.

5.4. Analysis of the Influence of Discount Rate on Incentive Coefficient and Enterprise Effort. Figures 7 and 8 show the impact of discount rate on government incentive coefficient

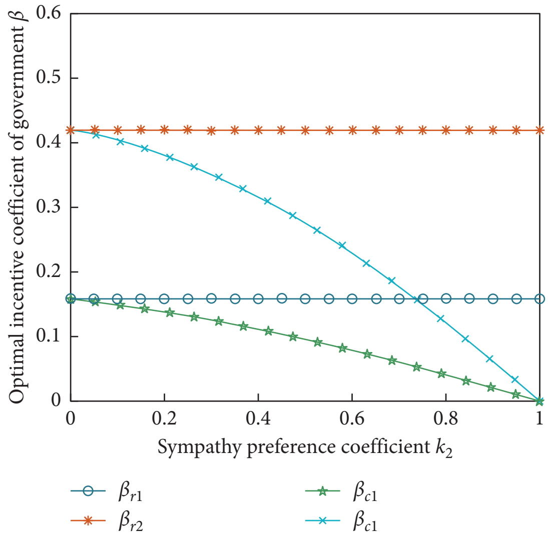

Figure 5: Government incentive coefficients under different k_2.

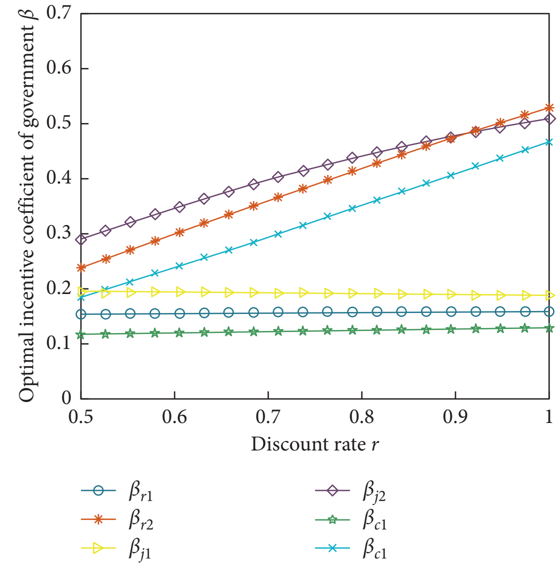

Figure 7: Government incentive coefficients under different r.

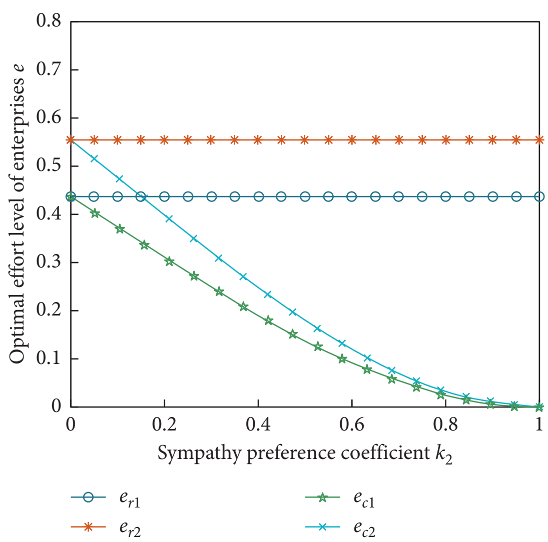

Figure 6: Corporate efforts under different k_2.

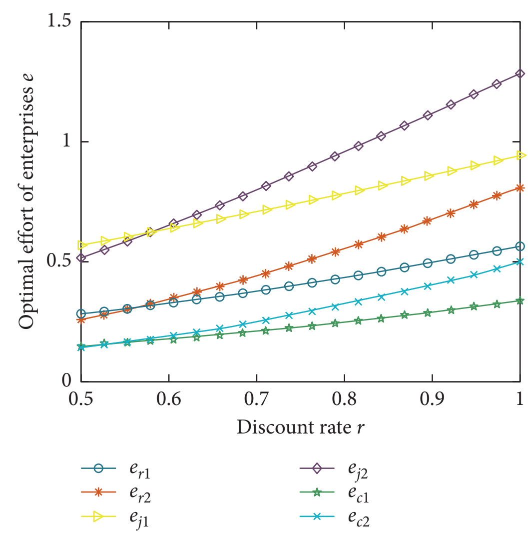

Figure 8: Corporate efforts under different r.

and enterprise effort, respectively. It can be seen from Figures 7 and 8 that with the increase of discount rate, the government's long-term incentive coefficient and the enterprise's effort under the three situations are increasing, but the government's short-term incentive coefficient is almost unchanged. The larger the discount rate is, the greater the current income of the enterprise's long-term efforts will be. Therefore, the government is willing to invest more subsidies to encourage enterprises to carry out long-term tasks. At the same time, enterprises are willing to invest more efforts to obtain the maximum benefits.

6. Conclusion

Considering the fairness preference of enterprises, a multiobjective incentive contract model for the government to reduce carbon emissions is constructed, and the optimal incentive strategy of the government under different circumstances is analyzed. Through numerical simulation analysis, the following research conclusions are obtained: (1) the fairness preference of companies will directly affect the government's incentive strategy for corporate carbon emission reduction. Enterprises with jealous preferences will increase their efforts, while those with compassionate preferences will reduce their efforts. Therefore, the government should also choose different incentive strategies according to the fairness preference characteristics of enterprises; (2) the enterprise's efforts for long-term tasks will be directly affected by the task correlation coefficient and the discount value of the long-term task. Therefore, when the government implements incentives to the enterprise, it is necessary to flexibly adjust the incentive strategy according to the task correlation coefficient and the discount rate.

In summary, in order to increase the level of corporate carbon emission reduction efforts, the government must not only consider the company's fairness preference psychology but also pay attention to the long-term and short-term performance of the task to design incentive contracts. Looking to the future, on the basis of this research, we can further study contracts including incentive mechanisms and disciplinary mechanisms or construct multiperiod incentive contracts to ensure the sustainability of carbon emissions reduction.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this article.

Authors' Contributions

Conceptualization and writing, original draft preparation, were carried out by Z. L.; the study was supervised by S. Z.; writing, review and editing, was done by Z. L. and S. Z.; project administration was carried out by S. Z. and C. X. All authors have read and agreed to the published version of the manuscript.

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