Research Article

Government Intervention and Subjectivity of Non-State-Owned Enterprises under “Double Carbon” Target

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Facing the challenge of increasingly serious environmental problems, the government has put forward the “Double Carbon” target. The government and the non-state-owned enterprises are the core participants of the “Double Carbon” target. The subjective game model is used to analyze the behavioral strategies of the government and non-state-owned enterprises in the process of achieving the “Double Carbon” goal. The research contents of this paper are as follows: Firstly, the relevant theories and literatures are summarized, and the necessity and contribution of this study are given. Secondly, the subjective game model between the government and non-state-owned enterprises under the “Double Carbon” goal is constructed. And the dynamic game equation, the dynamic game equilibrium, and the dynamic evolution process of the game subject are analyzed and discussed. Then, the influencing factors of the decision-making of the game subject are analyzed. Finally, the following conclusions are drawn. When the government do not take any action, non-state-owned enterprises generally do not actively participate in the “Double Carbon” target. In order to promote non-state-owned enterprises to actively participate in the “Double Carbon” goal, the government should adopt the policy of subsidy and incentive to reduce the entry threshold and entry barrier of non-state-owned enterprises. In order to maximize the benefit of the “Double Carbon” goal, the government should take punitive measures at the same time. The government should further improve the corresponding laws and regulations and improve the property rights trading market. Actively guide and regulate the behavior of non-state-owned enterprises to achieve the goal of “Double Carbon,” and bring greater social benefit.

1. Introduction

Climate change caused by greenhouse gas emissions is one of the major challenges of mankind. In this context, China proposed the goal of “carbon emissions should peak before 2030 and achieve carbon neutrality by 2060” in September 2020. And take the “Double Carbon” goal into the overall layout of ecological civilization construction, aiming to contribute to global climate governance. In fact, since the 18th CPC National Congress, China has begun to comprehensively promote the construction of ecological civilization. The core participants of the “Double Carbon” target including the government and non-state-owned enterprises. In the process of realizing the “Double Carbon” target, choosing strategy of both sides is a game process. In this game, the behavior of non-state-owned enterprises is affected by the behavior of the government. At the same time, the behavior of the government will also be affected by the behavior of non-state-owned enterprises. How the actions will affect each other? What kind of equilibrium state will be produced, and what factors will affect these equilibria in the process of the game? Analysis of this article not only helps the government to promote non-state-owned enterprises to actively participate in the “Double Carbon” target but also provides
a certain reference significance for the government to achieve the maximum benefit in the process of realizing the "Double Carbon" target.

2. The Theory Analysis and Literature Review

2.1. The Theory Analysis. The government has set "Double Carbon" target from the macro level, which is a great event for the country and the people, and its main responders are non-state-owned enterprises. Both the government and non-state-owned enterprises are relatively rational and independent. In the process of realizing the "Double Carbon" goal, the behaviors of the government and non-state-owned enterprises will be affected by various factors. The whole process is a subjective game. Whether the government and non-state-owned enterprises adopt new behavioral strategies is affected not only by their own interest and cost but also by the behavior of the other party. The theory represented by Masahiko Aoki builds a subjective game model based on the classic game and evolutionary game, which integrates internal and external causes in the evolutionary process to a certain extent, and is more appropriate for analyzing the behavior pattern, behavior logic, and behavior path of the government and non-state-owned enterprises under the "Double Carbon" goal. There are two main problems in the application of traditional game theory. The first is the problem of "timing effect." The static game defined in the traditional game theory refers to that the participants act at the same time or the latter actors do not know the specific actions taken by the first actors. Either a completely static game or a completely dynamic game. The second is the problem of repeated game. Traditional game theory classifies repeated game as a kind of dynamic game, but this cannot explain the phenomenon of rapid access to information and rapid learning. Based on the above two points, the following amendments are made when constructing the subjective game model. When building the model, the subjective game is considered a semistatic and semidynamic process, because the subjective game is neither completely static nor completely dynamic. It is a game between the two. In order to make the game model more suitable for this study better, it is assumed that both sides have limited rationality and the ability to quickly acquire knowledge and learn. Secondly, the process of dynamic game is regarded as an infinite repeated process. According to different stages, the evolution process of game is analyzed and discussed in detail. Since the internal main factors affecting both sides of the game are extremely complex, it is impossible to consider each situation. For the convenience of the study, the characteristics of both sides of the game are combined to make a selection of the main influencing factors and analyze the behavior of both sides of the subjective game.

The basic idea of subjective game is that both sides of the game have limited rationality and subjective initiative; in other words, both sides of the game will measure their own interests according to their own cognitive level, the behavior, and measures of the other side and adopt different behavioral strategies at different stages of the game. Both sides of the game have the independence of behavior decision-making. Based on the profit-seeking nature of the game subject, both sides of the game will comprehensively consider the influence of various factors. When the benefit of a behavior is significantly greater than the cost, they will change their own behavior. For the government, whether to change its behavior depends on the overall social benefit. If the behavior brings large overall social benefit or it will bring significant social benefit in the long run, the government will still choose to change the behavior even though it may bear a large cost in the short term. For non-state-owned enterprises, the major factor of making the decision is profit maximization. Kalai and Lehrer [1] and Matsushima [2] studied the game in a given subjective game model and discusses the nature of subjective game equilibrium. Nash equilibrium is the most important concept in game theory. It describes a situation in which it is not worthwhile for any player to change his strategy alone. Nash equilibrium is based on the "perfectly rational" assumption of modern game theory, which requires players to be capable of "infinite regression reasoning." Therefore, no matter how the government and non-state-owned enterprises play the game, the game between the government and non-state-owned enterprises will eventually reach an equilibrium state.

Since the game of government enterprises is not one-time, but repeated many times, referring to the "PDCA" cycle of Deming cycle, according to the behavior strategies of government and non-state-owned enterprises, the "POAC" cycle and "OPAC" cycle were proposed, respectively, for the government and non-state-owned enterprises. The "P" refers to the PLAN, the "O" refers to the observation, the "A" refers to the ACT, and the "C" refers to the CHECK. For the government, make the "Double Carbon" planning first; then observe the degree of the "Double Carbon" target. In order to achieve the "Double Carbon," the government will take certain action, after the action, will check and evaluate the results of action, and then make the next step of action, namely, "POAC" cycle. For the non-state-owned enterprises, after the government’s "Double Carbon" formulated by the goal, take the attitude of observation first, comprehensively measure its own interests, and then make a decision whether to participate in, but with the implementation of the government intervention strategies, due to the interests of non-state-owned enterprises, they will change its strategy, participate in the "double carbon" goal, and, finally, check the adopted strategy and adjust the new strategy, that is, the "OPAC" cycle. The game between the government and non-state-owned enterprises is shown in Figure 1.

2.2. Literature Review. In recent years, the issue of "carbon" has become the focus of scholars. Many scholars have made researches on this issue from different aspects. These literatures can be mainly divided into the following three aspects:

(i) Carbon emissions: since the reform and openness, China's economy has developed quickly. However, with the rapid development of economy, environmental problems and consequences caused by using
fossil energy have become increasingly serious, which has aroused people's attention to carbon emissions. First, Wu et al. [3] and Wang Feng et al. [4] studied the driving factors of carbon emissions. Related scholars have studied population situation and consumption pattern [5], industrial structure [6], environmental regulation [7], and other factors on the impact of carbon emission analysis. The results showed that the impact of household consumption and population structure change on China's carbon emissions has exceeded the single impact of population size, carbon emissions and industrial structure have a long-term equilibrium cointegration relationship, and environmental regulation has a direct effect on carbon emissions. Yuan and Jie [8] and Youguo and Yujie [9] studied the impact of industrial structure evolution on carbon emissions and the path to achieve the goal of "Double Carbon." Edenhofer et al. [10], Chen Xiaohong et al. [11], Weiyue et al. [12], and Guojun et al. [13] studied the relevant policies, implementation paths, and optimization methods of carbon emission control. Yinyin et al. [14] and Xiliang et al. [15] assessed the effects of carbon emission reduction. Secondly, building low-carbon cities to reduce carbon emissions is also an effective method. Yixin [16], Yun et al. [17], and Wenlin and Can [18] studied low-carbon city connotation, model, goals, strategy, evaluation method, model supporting system, practice, and development of the construction of low-carbon cities from the necessity of low-carbon city, and relevant suggestion is given. Finally, Ye and Qin [19], Xiangwan [20], Jun et al. [21], and Zhijun et al. [22] improved the road of green development with Chinese characteristics from the aspects of sustainable development, the construction theory and practice of ecological civilization, the innovative economy of ecological civilization, the strategic framework, and the path design of low-carbon transition, coping with climate change and transformation development.

(ii) Low-carbon economy: nowadays, the overall characteristics of the Chinese economy have been “slow but stable, improving and making progress while maintaining stability.” However, China's carbon emission situation is serious with the development of economy. Environmental problems increasingly attract people's attention. Low-carbon economy plays an important role in achieving rapid and sound development. First, Jian and Hui [23], Dali and Shuai [24], and Shijiao [25] analyzed the evaluation indicators and influencing factors of low-carbon economy and provided policy suggestions and implementation paths. Jun et al. [26], Bimei [27], and Xiaojia et al. [28] studied the influencing factors, evaluation index system construction, and development path of low-carbon economy from the regional perspective. Secondly, Nicolai et al. [29] evaluated the necessity and feasibility of low-carbon economic development in the context of climate change from the perspective of economics. Tiffers et al. [30], Shimada et al. [31], and other scholars proposed their own paths and policy suggestions for the development of low-carbon economy in their own countries. Jing and Weiping [32], Dawei [33], Liangwen et al. [34], and Yongju [35] analyzed the current situation and trend of low-carbon economic development abroad and put forward relevant policy suggestions and development paths for China's low-carbon economic development. Besides, carbon finance is key to low-carbon economy. Qian and Yao [36], Bo et al. [37], Haishu et al. [38], and Chen et al. [39] studied the latest progress, development status, and development strategies of carbon finance. Finally, carbon finance promotes the adjustment and transformation of industrial structure and the reenactment of laws.

(iii) Low-carbon development: as environmental problems become more and more serious, low-
carbon development becomes more and more important. To carry out low-carbon development, the probe of energy should be solved first. Only by carrying out low-carbon transformation of energy can we better carry out low-carbon development. First, renewable energy should be developed. Fisher et al. [40] and Fan et al. [41] believed that the decline of energy intensity was the main reason for the reduction of carbon emissions. Limei et al. [42], Shunkun et al. [43], and Yang et al. [44] conducted research on China’s energy situation and challenges. It was pointed out that the development of renewable energy requires the coordination of energy technologies in various fields and the support and control of national policies. The second is power resources. If electricity can be used to replace fossil energy on a large scale, carbon emissions can be significantly reduced and low-carbon development promoted. Jianhua et al. [45], Xiaohui et al. [46], and Chun et al. [47] pointed out that the power industry is in urgent need of transformation by studying the limiting factors of the existing power industry. The government should increase investment incentives, improve the market mechanism of renewable energy, deeply tap the potential of demand-side resources, and strengthen supervision. Finally, low-carbon technology should be used to promote low-carbon development. Xiaodong et al. [48], Shoudao and Jianbo [49], Shoujun et al. [50], and Xueyi and Zheng [51] studied the development of low-carbon technologies, though in the process of low carbon development it should be for low-carbon technology innovation, low-carbon technology combined application. The government should increase the incentive system and promote the application and development of low-carbon technology through institutional reform. Li proposed countermeasures for the development of low-carbon economy in China from the perspective of sustainable development [52]. In addition, Dalin et al. [53], Dan and Weifeng [54], and Ru and Zhide [55], from the perspective of low-carbon agriculture, believed that the development of agriculture should also take low-carbon as the goal and adopt a new low-carbon development mode.

Those literatures either studied the behavioral strategies that the government should adopt under the “Double Carbon” target from the global perspective or studied the behavioral strategies that the relevant responders should adopt under the “Double Carbon” target from the regional perspective. No matter from which angle to study, the government and the relevant responders are regarded as a relatively static party. But it turns out that it is not true. Both the government and the relevant responders are in a dynamic environment and will change their behavior in time according to the behavior of the other party. With the formal proposal of the “Double Carbon” target, due to the relative rationality and profit-seeking nature of the government and the responders, the role of self-regulation of the government is gradually reduced. The realization of the “Double Carbon” target requires the guidance and regulation of the government. In the process of development, the government and non-state-owned enterprises have gradually become the core subjects of the “Double Carbon” target. Non-state-owned enterprises will adopt corresponding strategies according to the government’s behavior. At the same time, the government will adopt new regulation means according to the behavior of non-state-owned enterprises. The subjective game model is used to analyze the behavioral strategies, the behavioral logic, and the influencing factors of the government and non-state-owned enterprises in the process of realizing the “Double Carbon” goal. Finally, get the stable equilibrium strategy of the subjective game model, and put forward policy suggestions for the government to achieve the “Double Carbon” goal on this basis.

Compared with the existing studies, the contributions are as follows: First, from the angle of the research, the main factor of state-owned enterprises and non-state-owned enterprises is the governmental behavior strategy, because the state-owned enterprise is under the control of the government, the behavior of the state-owned enterprises is the embodiment of the government policy objectives, and non-state-owned enterprise is the core of government policy target responder. Therefore, in order to accurately study the realization of “Double Carbon” goal and better promote the realization of this goal, the perspective of the government and non-state-owned enterprises should be analyzed. Second, in a research method, considering the subjective game of both sides of behavior characteristics and the complexity of the influencing factors, in order to facilitate research and combine the characteristics of the “Double Carbon” target, the government behavior and non-state-owned enterprises strategy selection process are depicted by using subjective game model; it enriches the relevant research about the “Double Carbon” goal and provides some reference significance to better realize the goal of “Double Carbon” in the future.

3. The Subjective Game Model Construction of the “Double Carbon” Goal between the Government and Non-State-Owned Enterprises

3.1. Research Hypothesis. Because government and non-state-owned enterprises are relatively rational, there is only one level of relative perception of the “Double Carbon” target, but they can take new actions through analysis. At the same time, the “Double Carbon” goal is a long-term process; no one can accurately determine the pros and cons of participation. The latter entrants can adjust their behavioral strategies according to the results of previous entrants’ participation. When the benefit of “Double Carbon” target is more than not participating, non-state-owned enterprises will participate in “Double Carbon” goal in a hurry; when the benefit of participating “Double Carbon” target is far less than not participating, non-state-owned enterprises will
evacuate. The government and non-state-owned enterprises will adjust their behavior according to the other’s behavior. Each time one partner’s behavior changes, the other adjusts its behavioral strategy in response to the other’s behavior. The change of the behavior strategy of the government and non-state-owned enterprises will continue for a long time, so the game between the two is a repeated and long-term process. Therefore, hypothesis 1 is proposed as follows:

(i) H1: both sides of the game have the ability to make relatively rational and subjective decisions. The game is a long-term and complex process.

In the course of the game, the government’s strategy is intervention and nonintervention when faced with whether non-state-owned enterprises will participate in the “Double Carbon” goal. The intervention strategy means that the government should guide the “Double Carbon” target, improve relevant laws and regulations, and establish new incentive and punishment mechanisms. Nonintervention policy means that the government maintains a neutral attitude, does not guide the “Double Carbon” target, and does not implement any policy intervention. The strategy of non-state-owned enterprises is participation and nonparticipation. Participation of non-state-owned enterprises in the “Double Carbon” goal can establish a good image for enterprises, which is beneficial to the future development. The main reason for non-state-owned enterprises do not participate in the “Double Carbon” target is that it will reduce their productivity. No matter how the government and non-state-owned enterprises choose, they will adjust their own strategies after the other party changes their behavioral strategies. Before the other party changes its behavioral strategies, one party cannot accurately obtain the behavioral strategies of the other party. Therefore, hypothesis 2 is proposed as follows:

(ii) H2: the behavior of both the government and non-state-owned enterprises will have an impact on the other party, and they cannot completely obtain the information of the change of the other party’s behavior strategy.

Although the game between the government and non-state-owned enterprises is a long-term and complex process. As the change of the external environment, this objective game will reach an equilibrium state. As the awareness of the “Double Carbon” goal deepens, the strategic choices of the government and non-state-owned enterprises will change. Non-state-owned enterprises aim to maximize corporate value, while the government is aimed not only at maximizing social benefit but also at achieving the “Double Carbon” goal. Every time one partner makes a behavioral strategy change, the other partner adjusts its behavior according to its own goals and the other partner’s behavior. Between the two is a game process; with the progress of the game, the two sides of the game will eventually tend to a relatively stable state. Therefore, hypothesis 3 is proposed as follows:

(iii) H3: the dynamic game between the government and non-state-owned enterprises will eventually reach an equilibrium state.

3.2. Type Building Model and Benefit Matrix of Both Sides in Chess Game. Under the influence of various factors in the game, the behavior of the main body is extremely complex. Every factor and every situation introduced into the model are impossible; in order to simplify the study in the process of the game, the following main variables are defined and the return function matrices of government and non-state-owned enterprises are listed.

In the initial state, the government’s income mainly comes from T0, the corporate income tax is paid by non-state-owned enterprises, and the income of non-state-owned enterprises is I0. The probability of the government they choose to intervene is n, and the probability of the government they choose not to intervene is 1 − n (0 ≤ n ≤ 1), while the probability of non-state-owned enterprises participating is m, and the probability of non-state-owned enterprises participating is 1 − m (0 ≤ m ≤ 1). If the government chooses to intervene in the “Double Carbon” target, for achieving the “Double Carbon” target better, the government should guide and undertake more important tasks, including formulating new policies and regulations, implementing relevant intervention policies, and establishing a sound incentive mechanism and strict punishment system. Assuming the cost of the government expenditure is G0. Non-state-owned enterprises, as one of the main players of the social market, will benefit from the improvement of the social system environment, regardless of whether they participate in the “Double Carbon” goal. The benefit of the non-state-owned enterprises is λG0 (0 ≤ λ ≤ 1).

In addition, in order to guide the behavior of non-state-owned enterprises, the government should implement subsidy and encouragement policies. Assuming that the government’s expenditure is H0 and E0. In order to guide the participation of non-state-owned enterprises, the government will give tax preference ΔT to those who participate in the “Double Carbon” goal. If non-state-owned enterprises choose to participate in the “Double Carbon” target actively, the “Double Carbon” target can be achieved without any government intervention, and greater benefit will be brought to the whole society. Of course, this is an ideal state. Due to the limited rationality of non-state-owned enterprises, their choice depends on the comparison of total social benefit brought by participation and nonparticipation. If the government does not intervene in the “Double Carbon” target, non-state-owned enterprises generally do not choose to participate in it for it will limit production and reduce their interests. Under the intervention of the government, non-state-owned enterprises still consider the inflow of benefit, participation cost, and loss brought by participation. Only when the net income is greater than its total cost, they will choose to participate; otherwise, they will still choose the strategy of nonparticipation. As time goes by, non-state-owned enterprises have a deeper understanding of the goal of “Double Carbon” and may change their behavior and take the initiative to participate in, but this is not entirely certain.
The income increase of non-state-owned enterprises while the government chooses to “intervene” in the “Double Carbon” goal is $\Delta I_1$, the income increase of non-state-owned enterprises while the government chooses to “not intervene” in the “Double Carbon” goal is $\Delta I_2$, and the improvement of economic benefit brought by non-state-owned enterprises’ participation is $\Delta I_3$.

The government believes that through the intervention of policy measures, the market will be regulated to achieve the goal of “Double Carbon.” No matter how the government intervenes, non-state-owned enterprises are likely to make some adverse choices for their own development. Although the government has made a large amount of investment, non-state-owned enterprises are still indifferent and do not participate in it, resulting in the waste of government investment. At this time, the default risk of non-state-owned enterprises should be considered. In the absence of government “intervention,” the cost and default risk of non-state-owned enterprises participating in the “Double Carbon” goal are recorded as $Rn$. In the case of government “intervention”, the government can improve the institutional environment by political power and formulate a severe punishment system. With the improvement of the system, the cost and the risk of default of non-state-owned companies involved in the “Double Carbon” target will gradually reduce to $Ri$ ($Ri < Rn$). However, due to the fact that the non-state-owned enterprises are bounded rationality, considering the cost and the benefit of participating in the “Double Carbon” target, the risk of default $Ri$ will no longer continue to lower after a certain level. The revenue function matrix of government and non-state-owned enterprises is shown in Table 1.

4. Subjective Game Analysis between Government and Non-State-Owned Enterprises under “Double Carbon” Goal

4.1. Analysis of Dynamic Game Equation. According to the revenue function matrix, the expected benefit of the government’s choice of intervention in the “Double Carbon” goal is as follows:

$$Rg_1 = m(T_0 + \Delta I_1 - G_0 - E_0 - H_0 - \Delta T) + (1 - m)(T_0 - G_0).$$

(1)

The expected benefit of the government’s choice of non-intervention in the “Double Carbon” goal is as follows:

$$Rg_2 = m(T_0 + \Delta I_2) + (1 - m)T_0.$$  

(2)

The average revenue of the government is as follows:

$$RR_1 = nRg_1 + (1 - n)Rg_2 = n[m(T_0 + \Delta I_1 - G_0 - E_0 - H_0 - \Delta T) + (1 - m)(T_0 - G_0)] + (1 - n)[m(T_0 + \Delta I_2) + (1 - m)T_0].$$

(3)

It can be concluded that the dynamic differential equation of the government’s “Double Carbon” target selection strategy is as follows:

$$F(n) = \frac{dn}{dt} = n(Rg_1 - Rg_2) = n(1 - n)[m(\Delta I_1 - E_0 - H_0 - \Delta T - \Delta I_2) - G_0].$$

(4)

Similarly, according to the income function matrix, the expected income of non-state-owned enterprises choosing to participate in the “Double Carbon” goal is as follows:

$$R_1 = n(I_0 + \lambda G_0 + E_0 + H_0 + \Delta T + \Delta I_3 - R_i) + (1 - n)(I_0 + \Delta I_3 - R_n).$$

(5)

The expected benefit of non-state-owned enterprises choosing not to participate in the “Double Carbon” goal is as follows:

$$R_2 = n(I_0 + \lambda G_0) + (1 - n)I_0.$$  

(6)

The average income of non-state-owned enterprises is as follows:

$$R_2 = mRe_1 + (1 - m)Re_2 = m[I_0 + \lambda G_0 + E_0 + H_0 + \Delta T + \Delta I_3 - Ri] + (1 - m)[I_0 + \lambda G_0 + (1 - n)I_0].$$

(7)

It can be concluded that the dynamic differential equation of non-state-owned enterprises in “Double Carbon” target selection strategy is as follows:

$$F(m) = \frac{dm}{dt} = m[Re_1 - Re_2] = m(1 - m)[n(E_0 + H_0 + \Delta T + R_n - Ri) + \Delta I_3 - R_n].$$

(8)

Equations (4) and (8) are the dynamic game process between the government and non-state-owned enterprises under the “Double Carbon” goal.

$$F(n) = \frac{dn}{dt} = n(Rg_1 - Rg_2) = n(1 - n)[m(\Delta I_1 - E_0 - H_0 - \Delta T - \Delta I_2) - G_0] > 0$$

$$F(m) = \frac{dm}{dt} = m(Re_1 - Re_2) = m(nE_0 + H_0 + \Delta T + R_n - Ri) + \Delta I_3 - R_n < 0$$

(9)

Solve the following:

(i) $n_1 = 0, n_2 = 1, m^* = G_0/(\Delta I_1 - E_0 - H_0 - \Delta T - \Delta I_2)$

(ii) $m_1 = 0, m_2 = 1, n^* = (R_n - \Delta I_3)/(E_0 + H_0 + \Delta T + R_n - Ri)$.

Five equilibrium points of the game between the government and non-state-owned enterprises can be obtained: $E_1(0, 0), E_2(0, 1), E_3(1, 0), E_4(1, 1)$, and $E_5(m^*, n^*)$; from $0 \leq m \leq 1, G_0 > 0$; conclude the following: $\Delta I_1 - E_0 - H_0 - \Delta T - \Delta I_2 > 0$; from $0 \leq n \leq 1, Ri, E_0 + H_0 + \Delta T + \Delta I_3 > 0$; conclude the following: $R_n - \Delta I_3 > 0$. 
Table 1: Revenue function matrix of government and non-state-owned enterprises.

| Government intervention: \( n \) | \( T_0 + \Delta I_1 - G_0 - E_0 - H_0 - \Delta T \) | \( 10 + \lambda G_0 + E_0 + H_0 + \Delta T + \Delta I_3 - R_i \) | Non-state-owned enterprises will not participate: \( 1 - m \) |
|--------------------------|-----------------|------------------|-----------------|
| Government do not intervene: \( 1 - n \) | \( T_0 + \Delta I_2 \) | \( 10 + \Delta I_3 - R_n \) | \( T_0 \) |

(i) According to the principle of dynamic differential equation, when \( F(n) = dn/dt = 0, F'(n) < 0, ni \) is stable strategy selection of government subjective game. From the government’s dynamic differential equation, if \( m = m^* = G_0/(\Delta I_1 - E_0 - H_0 - \Delta T - \Delta I_2) \), when \( F(n) = dn/dt = 0, F'(n) = 0 \), then all the strategies selected are optimal stable strategies for \( F(n) \). That is to say, when the degree of participation of non-state-owned enterprises is reached \( m = m^* = G_0/(\Delta I_1 - E_0 - H_0 - \Delta T - \Delta I_2) \), government support strategies are stable.

If \( m < G_0/(\Delta I_1 - E_0 - H_0 - \Delta T - \Delta I_2) \), when \( n_1 = 0, n_2 = 1, F'(n_1) < 0, F'(n_2) < 0 \), then \( n_1^* = 0 \) is the government’s best strategic choice point. In other words, when the non-state-owned enterprises choose not to participate in the “Double Carbon” goal and the cost of the government continued to increase and the return of government that chooses to participate in the “Double Carbon” target will be more and more small, the government that chooses not to interfere in non-state-owned enterprises to participate in “Double Carbon” target is the best choice of the strategy.

If \( m > G_0/(\Delta I_1 - E_0 - H_0 - \Delta T - \Delta I_2) \), when \( n_1 = 0, n_2 = 1, F'(n_1) > 0, F'(n_2) < 0 \), then \( n_2^* = 1 \) is the government’s best strategic choice point. In other words, when the non-state-owned enterprises choose to participate in the “Double Carbon” goal and the possibility of participation continued to increase, non-state-owned enterprises that participate in the “Double Carbon” target choice probability will be more and more big from the view point of bounded rationality of the government; at this point, the choice of governmental intervention non-state-owned enterprises to participate in “Double Carbon” target is the best choice of the strategy.

(ii) By the same token, when \( F(m) = dm/dt = 0, F'(m) < 0, mi \) is the stable strategy choice of non-state-owned enterprise subjective game. According to the dynamic differential equation of non-state-owned enterprises, if \( n = n^* = (R_n - \Delta I_3)/(E_0 + H_0 + \Delta T + R_n - R_i) \), then \( F(m) = dm/dt = 0, F'(m) = 0 \), at this time, all the strategies selected are optimal stable strategies for \( F(m) \). In other words, when the level of government intervention is reached \( m = m^* = G_0/(\Delta I_1 - E_0 - H_0 - \Delta T - \Delta I_2) \), the strategy of non-state-owned enterprises choosing to participate in the “Double Carbon” target is stable.

If \( n < (R_n - \Delta I_3)/(E_0 + H_0 + \Delta T + R_n - R_i) \), when \( m_1 = 0, m_2 = 1, F'(m_1) < 0, F'(m_2) > 0 \), then \( n_1^* = 0 \) is the best strategy choice point for non-state-owned enterprises. In other words, when the degree of government intervention does not reach a certain level and this level gradually decreases, it is the best choice for non-state-owned enterprises not to participate in the “Double Carbon” target.

If \( n > (R_n - \Delta I_3)/(E_0 + H_0 + \Delta T + R_n - R_i) \), when \( m_1 = 0, m_2 = 1, F'(m_1) > 0, F'(m_2) < 0 \), then \( n_2^* = 1 \) is the only optimal strategy choice point for non-state-owned enterprises. In other words, when the degree of government intervention reaches a certain level and the degree of intervention gradually increases, it is the best choice for non-state-owned enterprises to participate in the “Double Carbon” target.

4.2. Stability Analysis of Chess Balance. Equilibrium point solved by dynamic differential equation is not necessarily the stable equilibrium strategy of both sides of the game. The stability of equilibrium point is analyzed by using the determinant and trace symbol of Jacobian matrix of game system proposed by Frildman. According to equations (4) and (8), the Jacobian matrix of the game system can be obtained as follows:

\[
\begin{bmatrix}
\frac{dn}{dt} \\
\frac{dm}{dt}
\end{bmatrix}
\begin{bmatrix}
\frac{dn}{dt} \\
\frac{dm}{dt}
\end{bmatrix}.
\]

Simplification leads to

\[
\text{Trace of the determinant} = (1 - 2n)[n(\Delta I_1 - E_0 - H_0 - \Delta T - \Delta I_2)] - n(1 - n)(\Delta I_1 - E_0 - H_0 - \Delta T - \Delta I_2) - G_0/(\Delta I_1 - E_0 - H_0 - \Delta T - \Delta I_2) - \Delta I_3 - R_i.
\]

\[
The \text{determinant notation} = (1 - 2n)[n(\Delta I_1 - E_0 - H_0 - \Delta T - \Delta I_2) - G_0 \cdot (1 - 2m)] + (1 - 2m)\Delta I_3 - R_n.
\]

Put the five equilibrium points \( E_1(0,0), E_2(0,1), E_3(1,0), E_4(1,1), \) and \( E_5(m^* , n^* ) \) into the trace and determinant symbol of the determinant, and the results are shown in Table 2:
in the case of government “intervention,” the cost and default risk of non-state-owned enterprises’ participation in the “Double Carbon” target $R_i$, the promotion of economic benefit brought by non-state-owned enterprises’ participation in the “Double Carbon” target $\Delta I$, all of these will affect non-state-owned enterprises’ choice of participating in the “Double Carbon” target. From $n^* = (R_n - \Delta I)/(E_0 + H_0 + \Delta T + R_n - R_i)$, conclude the following: $R_i$ and $n^*$ are positive relationship, and $\Delta I$, $E_0$, $H_0$, $\Delta T$, and $n$ are the inverse relationship. When $R_i$ reduced, $\Delta I$, $E_0$, $H_0$, and $\Delta T$ grow, $n > n^*$; the optimal policy choice for non-state-owned enterprises is “participation” at these conditions.

According to equation (4), $F'(n) = (1 - 2n)[m(\Delta I - E_0 - H_0 - \Delta T - \Delta I)]$, then the government chooses to “intervene” in the increase of income obtained by non-state-owned enterprises participating in the “Double Carbon” target $\Delta I$, government incentive $E_0$, government subsidy $H_0$, and the tax incentive to non-state-owned enterprises to participate in the “Double Carbon” target $\Delta T$; the government chooses “not to interfere” with the increase in revenue from non-state-owned enterprises participating in the “Double Carbon” target $\Delta I$, government expenditure $G_0$; all of these will affect whether the government takes the policy of intervention. From $m^* = G_0/(\Delta I - E_0 - H_0 - \Delta T - \Delta I)$, $G_0$, $E_0$, $H_0$, $\Delta T$, $\Delta I$, and $m^*$ are positive relationship, and $\Delta I$ and $m^*$ are the inverse relationship. From $m^* > m$, conclude the following: $E_0$, $H_0$, and $\Delta T$ grow, when the increase in $E_0$, $H_0$, and $\Delta T$ is less than the decrease in $\Delta I$, $m > m^*$; the government’s best strategy is to intervene at this point.

Similarly, in order to make the government and non-state-owned enterprises in another stable state [no intervention, no participation], the strategic choice of the government and non-state-owned enterprises should fall at the lower left of the saddle point; then $n < (R_n - \Delta I)/(E_0 + H_0 + \Delta T + R_n - R_i)$, and $m < G_0/(\Delta I - E_0 - H_0 - \Delta T - \Delta I)$. When $E_0$, $H_0$, and $\Delta T$ reduced, $\Delta I$ reduces and $R_n$ grows, $n < n^*$; the best strategy for non-state-owned enterprises is not to participate at this point. When the decrease in $E_0$, $H_0$, and $\Delta T$ is less than the increase in $\Delta I$, $m < m^*$, the government’s best strategy is not to intervene.

4.3. Subjective Game Analysis between Government and Non-State-Owned Enterprises under Dynamic Evolution. From the phase diagram, the government and non-state-owned enterprises tend to two equilibrium states in the subjective game. First, consider the first stable state, and the policy choice of the government and non-state-owned enterprises tends to [intervention, participation]. At this point, the strategic choice between the government and non-state-owned enterprises should fall on the upper right of the saddle point, then $n > (R_n - \Delta I)/(E_0 + H_0 + \Delta T + R_n - R_i)$, and $m > G_0/(\Delta I - E_0 - H_0 - \Delta T - \Delta I)$.

According to equation (8), $F'(m) = (1 - 2m)[m(E_0 + H_0 + \Delta T + R_n - R_i) + \Delta I]/R_n$, then government incentives $E_0$, government subsidy $H_0$, the government gives tax incentive to non-state-owned enterprises to participate in the “Double Carbon” target $\Delta T$, and the cost and default risk of non-state-owned enterprises participating in the “Double Carbon” target without government “intervention” are denoted as $R_n$.
state-owned enterprises to participate in the “Double Carbon” target at the beginning. If all non-state-owned enterprises participate in the “Double Carbon” target, the game is over, but this is not the case. Non-state-owned enterprises will weigh the cost and benefit of participating in the “Double Carbon” target and decide whether to participate. If the profit of participation is significantly greater than the cost, they will choose to participate in the strategy; otherwise, they will not participate in the strategy. Since the “Double Carbon” goal will limit the production of enterprises, they generally choose not to participate in the strategy. If the government abandon the “Double Carbon” goals, it is the end of the game. On the other hand, the government will choose the strategy of intervention, and the government will play a guiding role, perfect for the corresponding laws and regulations. If all non-state-owned enterprises participate in the “Double Carbon” goal under the guidance of the government, it is the end of the game, but due to the fact that non-state-owned enterprises are bounded rationality, they will take the maximization of enterprise value as the goal. Considering that participating in the “Double Carbon” goal will limit the production of enterprises, they may choose to enjoy the benefit brought by the improvement of laws and regulations instead of participating in it. If the government accept the result, they will choose not to interfere in the policy; on the other hand, the government will choose the strategy of intervention. In order to promote non-state-owned enterprises to participate in “Double Carbon” target, the government will establish the corresponding incentive mechanism and enterprise certain subsidy. How the state-owned enterprises choose depends on the cost and the benefit participate the “Double Carbon” goal. If the total benefit is greater than the sum of the total loss and cost, the non-state-owned enterprises will participate in it; otherwise, the non-state-owned enterprises will not participate in it. If the government is satisfied with the current result, it will not intervene in the market and adjust it completely by relying on the law of the market. Otherwise, the government will choose the strategy of participation and formulate corresponding punishment measures. Non-state-owned enterprises will also measure the benefit of participating in the “Double Carbon” goal and the punishment to not participate in the “Double Carbon” goal. If they do not participate in the “Double Carbon” target, they suffer punishment less than not participating in the benefit from the “Double Carbon” goal; the non-state-owned enterprises will not participate in it; otherwise, the non-state-owned enterprises will participate in. By the behavior of the government, non-state-owned enterprises will also adjust their behavior according to the government’s behavior, which is a long and complicated process.

5.1. Analysis of Government Behavior Decision under Dynamic Game

(i) The degree of regulation of market laws: the market has a certain self-regulation ability. If this regulation ability can achieve the goal the government wants, the government will take a neutral attitude and not intervene in the market. Due to the limitations of market regulation, the government will intervene in the market only when the market regulation fails to reach the expected goal. Under the government’s control, the market may achieve the expected goal, and the government will not conduct further regulation. On the contrary, if the expected goal is still not achieved under the government’s control, the government will continue to increase regulation until the goal is achieved. However, it is also necessary to consider the cost paid by the government and the total social benefit brought by it. If it takes lots of manpower and material resources to realize the “Double Carbon” goal, but the overall social benefit brought by the realization is less than the cost, then giving up the goal is the optimal choice.

(ii) The degree of achieving the “Double Carbon” goal: the government has set a target of “Peak Carbon” by 2030 and “Carbon Neutral” by 2060 and will not intervene if market forces dictate this. It is precisely that this goal cannot be achieved by market adjustment that the government needs to step in to adjust. The government is a powerful regulator of the market, and its measures mainly include the following: perfecting relevant laws and regulations; issuing new laws and regulations; establishing incentive; subsidy and punishment mechanisms, etc.; and relying on external force to intervene in the behavior of non-state-owned enterprises. If the goal is achieved at some stage, the government will not take further step; otherwise, it will continue to intervene.

(iii) The input, cost, and total social benefit of the government when choosing the intervention strategy: as an institution of limited rationality, the government should not only achieve the established “Double Carbon” goal but also consider the total cost paid by the intervention policies and the total benefit brought by them. Government subsidy and incentive need a large of money support, establish new laws and regulations, and ensure the realization of these new laws and regulations also need enormous manpower material resources. If the cost of the government’s investment is less than its overall social benefit brought by the prognosis, although did not achieve “Double Carbon,” the government should also choose not to intervention strategies. Only when the overall social benefit after adjustment is significantly higher than the cost will the government choose the intervention strategy to achieve the goal of “Double Carbon.”

5.2. Behavior Decision Analysis of Non-State-Owned Enterprises under Dynamic Game

(i) The attraction of the “Double Carbon” target and the government’s behavioral strategies: if the “Double Carbon” target is attractive, non-state-owned
enterprises will naturally participate in it. However, it is obvious that the “Double Carbon” target is not attractive, because it cannot directly create substantial profit increase for non-state-owned enterprises. At this time, in order to guide the participation of non-state-owned enterprises and achieve the goal of “Double Carbon,” the government will improve relevant laws and regulations and make a series of policies such as incentive, subsidy, and punishment. At this time, non-state-owned enterprises may adjust their strategic choices and participate in the process in order to obtain such extra benefit. But with no punishment, although the government will offer certain incentive and subsidy, some non-state-owned enterprises will still choose not to participate in the strategy. They do not want to be the first person to eat crab; there are some companies will comply with the policy of the government, actively involved. Whether non-state-owned enterprises participate in the “Double Carbon” goal is affected by many factors.

(ii) The loss, cost, and total benefit of non-state-owned enterprises when participating in the “Double Carbon” goal: Non-state-owned enterprises are also rational ones, whose fundamental goal is to maximize their profit. Participating in the “Double Carbon” goal means the non-state-owned enterprises may reduce the level of productivity; it will reduce enterprise profit but also can obtain the government incentive and subsidy; the non-state-owned enterprises will measure the size between the two; if its total loss and the cost are less than its total profit, they will choose to participate in the strategy; on the other hand, they will choose not to participate in the strategy. In addition, for the government’s penalties, non-state-owned enterprises will consider penalties and the benefit of participating in the “Double Carbon” target; if the punishment is too small, non-state-owned enterprises prefer to be punished instead of participating. If the punishment is too big, they will impede the development of the market; how to determine the appropriate punishment is a key point.

(iii) The cognition degree of non-state-owned enterprises to the “Double Carbon” goal: as time goes by, more and more enterprises will realize that participating in the “Double Carbon” goal is not only for the gain of their own interest but also to make contributions to the human survival. In addition, participating in the “Double Carbon” target will also establish a good image for themselves, which is more conducive to the future development. Therefore, the more non-state-owned enterprises have a deeper understanding of the “Double Carbon” target, the more likely they are going to participate in it spontaneously. At this time, the government does not need to carry out any intervention. The early stage of the government may need a lot of input cost, but with the development of the time, the non-state-owned enterprises’ cognition of the target of “Double Carbon” is gradually deepening, and the more likely it is consciously involved and reduces the cost of the government, but this is not absolute. Whether they choose to participate in the “Double Carbon” goal, the most important thing is to consider the level of economic benefit brought to the enterprise by participating or not participating.

6. Conclusions

The subjective game model put forward by Aoki Masahiko is referenced to analyze the “Double Carbon” goal and the game behavior of the government and state-owned enterprises’ strategy choice, and we get the following conclusions:

(i) Non-state-owned enterprises are one of the important participants of achieving “Double Carbon”: its behavior is largely influenced by government behavior. At the same time, its behavior strategy will affect the behavior of the government. In the process of government and non-state-owned enterprises to participate in the game, intervention strategies for the government depending on how to achieve the goal of “Double Carbon” and the comparison between cost and social benefit, if the government’s intervention can bring a greater contribution to the society, the more likely the government chooses intervention strategies. If the realization of the “Double Carbon” goal can improve the market environment and make full use of resources in the long run, the government will still take the strategy of intervention although it will bear a large cost in the short term due to guiding, encouraging and subsidizing non-state-owned enterprises, perfecting laws and regulations, and formulating punishment measures. For non-state-owned enterprises, participating in it depends on the attraction of the “Double Carbon” target and the comparison between cost and total benefit of participation; if under the government subsidy and incentive, the cost and loss of the non-state-owned enterprises that participate in it are less than the total economic benefit of inflows, non-state-owned enterprises will choose to participate in the strategy. In addition, as non-state-owned enterprises become more and more aware of the “Double Carbon” target, participating in the “Double Carbon” target will establish a good image for the enterprise, which is beneficial to the future development of the enterprise; non-state-owned enterprises will also adopt the strategy of participation

(ii) In the process of achieving the “Double Carbon” goal, the government’s behavior plays a crucial role. First, the government should improve the relevant laws and regulations. Whether non-state-owned
realizing the synergistic effect between non-state-owned enterprises and the government based on their respective responsibilities. The perfect realization of the system brings benefit to the whole market and is more conducive to the realization of the “Double Carbon” goal. Secondly, incentive and subsidy mechanisms should be established. In order to promote non-state-owned enterprises to participate in the “Double Carbon” target, the government needs to provide some guidance. In the absence of government intervention, non-state-owned enterprises will not actively participate in the “Double Carbon” target. In order to achieve this goal, certain measures must be used to intervene, such as taking certain incentive and subsidy policies. In addition, the incentive and subsidy policy should be appropriate; if incentives and subsidies are too small, it will not lead to the role of the non-state-owned enterprises to participate in; if there are excessive incentive and subsidy, they can achieve the purpose of the “Double Carbon,” but it is likely to lead to the total social revenue which is less than the cost. At this time, the government takes no intervention strategy which is the best choice of the strategy. Finally, establish certain penalties. Although the government’s incentive and subsidy policies will guide the participation of non-state-owned enterprises, due to the independence of non-state-owned enterprises, there is a certain default risk; the government should formulate appropriate punishment measures to reduce the default risk of non-state-owned enterprises. The punishment measures should also be moderate; if the punishment is too light, non-state-owned enterprises may prefer to accept the punishment rather than participate in; thus, it will fail to reduce the risk of default; however, if the punishment is too heavy, it is not conducive to the development of the whole society.

Combined with the actual situation and the conclusion, realizing the synergistic effect between non-state-owned enterprises and the government based on their respective advantages, the government should promote the realization of the “Double Carbon” goal from the policy level. Given the profit-seeking nature of non-state-owned enterprises, the government needs to use a combination of incentive, subsidy, and punishment to promote the achievement of its goal. Only by formulating appropriate incentive, subsidy, and punishment measures can we ensure that the default risk of non-state-owned enterprises is minimized and the overall benefit brought to society is maximized. In the process of realizing the “Double Carbon” target, the more reasonable the policies formulated by the government, the more effective it will be to guide non-state-owned enterprises to participate in the “Double Carbon” target and the greater the social benefit. This study not only has reference significance on how to improve the active participation of non-state-owned enterprises but also has certain reference significance for the efficient realization of “Double Carbon” target. Besides, the research has certain reference significance for the optimal strategy selection of the dynamic game between the government and non-state-owned enterprises, which can be adjusted by the relevant factors that affect the decision-making of both parties, so as to maximize the interests of both parties. However, further research is needed on how to conduct detailed research on these factors. In addition, since it is impossible to take all factors into account in the game model, it is impossible to take every situation into account, other influencing factors and situations should be studied in future studies.

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 declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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