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Construction of a Benchmark Model for the Evolution of Government Enterprise Cooperation under the ESG Concept

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Abstract: The cooperation between government and enterprises has continued to deepen, evolving from a traditional model to a new model. Now, the cooperation between the government and enterprises has shifted from simple resource exchange to an effective combination of more complex platform construction, system development, and other projects. The two sides would work together to complete the cooperation project on the basis of equal dialogue and consensus. This article focused on exploring how to establish a stable cooperation strategy between the government and enterprises, as well as the evolving relationship of government enterprise cooperation with equal status. This article adopted evolutionary game theory to construct a benchmark model for government enterprise cooperation based on stable strategies. Through research and analysis, it was found that the optimal evolutionary stable strategy point between the government and enterprises was (1,1). At this point, the government would choose to actively cooperate, and enterprises would choose to provide high-quality products or services. Finally, simulation methods were used to analyze the evolution of government led government enterprise cooperation and the results of equal cooperation between both parties. The result showed that the time required for government led government enterprise cooperation to reach stability was shorter than the time required for both parties to reach stability under equal conditions. Therefore, when enterprises engage in behaviors that are not in line with the public's interests, the government needs to use strong dominant behavior to increase the punishment of enterprises, in order to ensure project interests, safeguard public rights, and promote the stable progress of the project.

1. Introduction

1.1. Evaluation Background and Significance

With the rapid development of the economy and society, the issues of unclear responsibilities,

inertia in collaboration, and lack of publicity among all parties involved in government enterprise cooperation are becoming increasingly prominent. At the same time, the people's demand for public services is also constantly changing, and diversified and personalized needs are constantly emerging, which poses higher challenges to the governance efficiency of the government [1-2]. From the current research, there are many factors that affect the value of a company, such as the internal and external environment of the enterprise. In the concept of ESG, the production, operation, and financial investment of enterprises should comprehensively consider various factors such as ecological environment protection, social responsibility, and corporate governance, rather than just focusing on economic indicators. In this sense, government enterprise cooperation is not only an economic behavior, but also a cultural behavior that requires corresponding organizational arrangements to ensure its implementation. Therefore, incorporating the ESG concept into the framework of government enterprise cooperation is expected to promote the evolution of new paradigms of government enterprise cooperation [3-4].

1.2. National Evaluation Status

Deepening cooperation between government and enterprises is an inevitable choice for the modernization of national governance system and governance capacity in the new era. The application of evolutionary game theory in government enterprise cooperation is also becoming increasingly widespread. Su N established a tripartite game evolution model for the government, enterprises, and higher education institutions, exploring the dynamic evolution process of collaborative innovation behavior under the government's choice of "incentive" and "non-incentive" strategies. The results indicated that under the premise of strong innovation awareness among governments and institutions, and low innovation costs for enterprises, the system is more likely to reach its ideal state [5]. Zhu Y P established an evolutionary game model for the government and enterprises to implement EPP (energy efficiency power plant) considering carbon emissions trading in the paper, analyzed the stability and evolution path of the model, and analyzed the impact of government rewards and punishments on the game balance through a numerical example. Finally, suggestions for optimizing the game results were given, including good government policy guidance, enterprise implementation strategies and reasonable carbon emission trading strategies, so as to create a good development environment for EPP [6]. Su Y constructed a tripartite evolutionary game model with the government, parent company, and subsidiary companies as the main entities in the paper to explore the laws and operational mechanisms of reverse knowledge transfer in China's high-tech industry under government intervention. The results indicated that under government intervention, there is varying degrees of mutual influence between the parent company and its subsidiaries. The active intervention of the government is conducive to stable cooperation between parent and subsidiary companies. However, over time, government intervention in independent innovation by multinational corporations has gradually relaxed [7]. From the research of the above scholars, it can be seen that evolutionary game theory is widely applied in various fields of government enterprise cooperation, but benchmark models for studying the evolution of government enterprise cooperation are relatively scarce.

Based on this, this article proposes to use evolutionary game theory to construct a benchmark model for government enterprise cooperation based on stable strategies.

2. Theoretical Introduction

2.1. ESG Concept

The full name of the ESG concept is "Environment, Society, and Corporate Governance". E

represents the environment; S represents society; G represents corporate governance. This is a performance evaluation standard that has been favored by companies and investors in recent years [8-9]. From the current research, there are many factors that affect the value of a company, such as the internal and external environment of the enterprise. In the operation and management of enterprises, the environmental aspect is a crucial factor that requires active measures to manage the external environment and achieve management goals. When considering the production and operation process of the enterprise itself, it is necessary to carefully consider its adverse effects on the environment. From the perspective of society, enterprises not only need to consider employee benefits and consumer interests, but also must assume responsibility for shareholders and the community where the enterprise is located and other stakeholders [10-11]. At the level of corporate governance, it is necessary to achieve collaborative cooperation among various entities within the enterprise, between enterprises, between enterprises and external governments, organizations and customers, in order to promote resource sharing and interdependence, and achieve management effects that surpass a single entity.

2.2. Evolutionary Game Theory

Evolutionary game theory first originated from the integration of rational economy and biology. It regards human beings as bounded rationality games, rather than perfect rationality people [12-13]. Evolutionary game theory provides a selection mechanism and a criterion for selecting stable strategies, which is defined as follows:

Assuming that there is a strategy m in the evolutionary game M. If there is a μ^0 that causes $f(m,(1-\mu)m+\mu\acute{m}) > f(\acute{m},(1-\mu)m+\mu\acute{m})$ for any $\acute{m} \neq m$ and $\mu \in (0,\mu^0]$, then the m strategy is an evolutionary stable strategy [14-15].

3. Evaluation of the Evolution of Government Enterprise Cooperation

3.1. Government Enterprise Cooperation Model

3.1.1 Government Enterprise Transactions

The main mode of cooperation in government enterprise transactions is to exchange funds for technology, and the decision-making power is in the hands of the government. The characteristic of this type of cooperation is short duration, non-long-term cooperation, unstable, but relatively low risk.

3.1.2 Government Enterprise Cooperation

The main way of cooperation between government and enterprises is to exchange data for technology, and the decision-making power remains in the hands of the government. The characteristic of this type of cooperation is that the cooperation time is relatively long and relatively stable, and the risk is relatively low, which was a relatively advocated cooperation method in the past.

3.1.3 Government Enterprise Co-governance

The main cooperation between government and enterprise co-governance is to exchange management power and data for technology, and the decision-making power does not only lie with the government, but also with the joint consultation of government and enterprise. This cooperation model has the characteristics of long cooperation time and stable cooperation relationship, but the

disadvantage is that the risk is relatively high.

3.2. Impact of ESM Concept on Government Enterprise Cooperation

3.2.1. The Impact of the Environment on Government Enterprise Cooperation

According to the theory of sustainable development theory, enterprises, as micro individuals in the economy, often take adverse actions against the long-term sustainable development of society for the sake of maximizing their own interests in their environmental behavior. Therefore, in government enterprise cooperation, the government can impose mandatory regulations on the environmental behavior of enterprises in their business activities through mandatory means [16].

3.2.2. The Impact of Social Responsibility on Government Enterprise Cooperation

Based on the stakeholder theory, the relationship between enterprises and the government cannot be viewed as an outsider, but rather as an insider in the overall development of the enterprise. The enterprise is viewed as an ecosystem that develops together with the government, thus forming an interconnected network environment. In this environment, the behavior of enterprises can have direct and indirect consequences, and the government should not only be the bearers of the economic consequences of enterprises, but also the creators of the economic consequences of enterprises [17-18].

3.2.3. The Impact of Corporate Governance on Government Enterprise Cooperation

From the perspective of agency theory, a sound corporate governance structure can effectively reduce agency costs. A sound and comprehensive corporate governance system can not only effectively reduce various opportunistic and speculative behaviors of modern enterprise managers in investment decisions and long-term business strategy decision-making processes, but also effectively regulate various investment decision-making activities of enterprise managers [19-20]. Under equal conditions, government enterprise cooperation is conducive to consultation and supervision between the government and enterprises.

3.3. Benchmark Model for Government Enterprise Cooperation Based on Stability Strategy

Assuming that both the government and the enterprise are bounded rationality people, when they are in the same position, there are two different cooperation modes between the government and the enterprise: “active cooperation” and “passive cooperation”. In this process, enterprises can also choose between providing high-quality or inferior products or services. Under this assumption, the following parameters can be set as:

A is the probability of a company providing high-quality products/services.

1-a is the probability of a company providing inferior products/services.

b is the probability of the government choosing to actively cooperate.

1-b is the probability of the government choosing negative cooperation.

E_s is the benefits that enterprises can obtain from providing products/services.

C_1 is the cost incurred by a company in providing high-quality products/services.

C_2 is the cost incurred by enterprises in providing inferior products/services.

D is the punishment imposed by the government on enterprises when they are found to provide inferior products/services.

H is the probability of discovering that companies provide inferior products/services when the government cooperates negatively. ($0<H<1$)

E_g is the basic benefits obtained from active cooperation between government departments and enterprises.

C_3 is the cost that government departments need to pay when actively cooperating.

ρC_3 is the cost that government departments need to pay when cooperating negatively. ($0 < \rho < 1$)

Based on the above parameters, the constructed evolutionary benchmark model is shown in Table 1.

Table 1: Evolution model of government enterprise operation

Social capital	Government	
	Negative cooperation	Active cooperation
Provide high quality services/products	$E_s - C_1, 0$	$E_s - C_1,\ E_g - C_3$
Provide low quality services/products	$E_s - C_2 - DH, 0$	$E_s - C_2 - D,\ E_g - C_3$

According to the evolution model of government enterprise cooperation in Table 1, the expected benefits that enterprises can obtain by providing high-quality products/services can be obtained:

$$O_1 = b(E_s - C_1) + (1 - b)(E_s - C_1) = E_s - C_1 \quad (1)$$

Expected benefits from providing inferior products/services:

$$O_2 = E_s - C_2 - bD - (1 - b)DH \quad (2)$$

The average expected return is:

$$\overline{O}_A = aO_1 + (1 - a)O_2 \quad (3)$$

The expected benefit that the government can achieve through active cooperation is:

$$O_3 = E_g - C_3 \quad (4)$$

The expected benefit of negative cooperation is:

$$O_4 = 0 \quad (5)$$

The average expected return is:

$$\overline{O}_B = b(E_g - C_3) \quad (6)$$

The replicator dynamic equation of an enterprise is:

$$F(a) = \frac{da}{dt} = a(O_1 - \overline{O}_A) = a(1 - a)[C_2 - C_1 + bD + (1 - b)DH] \quad (7)$$

The replicator dynamic formula of the government is:

$$F(b) = \frac{db}{dt} = b(O_3 - \overline{O}_b) = b(1 - b)(E_g - C_3) \quad (8)$$

On the basis of stability analysis and with equal status between the government and enterprises, the evolutionary stability equilibrium points between the government and enterprises can be analyzed through the evolutionary strategy adjustment formula as O(0,0), I(0,1), J(1,0) and K(1,1). This article uses the plane cartesian coordinate system aob as a tool to analyze the dynamic evolution of government enterprise relations and obtain six different scenarios of government enterprise cooperation evolution relationship diagrams.

When $C_1 - C_2 - D < 0$ and $E_g > C_3$, the evolution diagram of government and enterprise is

(As shown in Figure 1):

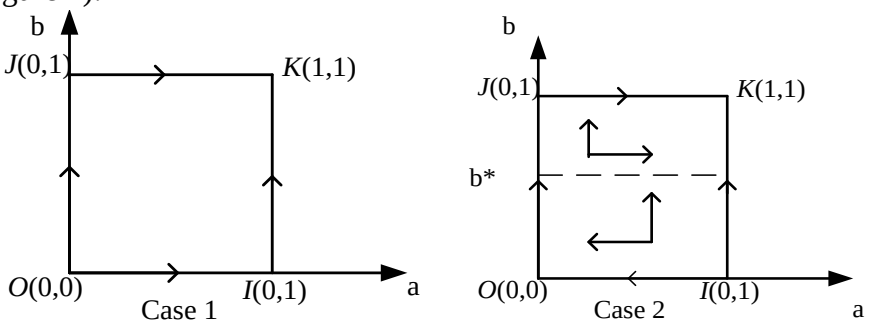

Figure 1: Case 1 and Case 2 of the government enterprise evolution chart

At this point, the evolution of government enterprise cooperation converges to (1,1), which is $C_1 - C_2 > D$, and the basic benefits of active cooperation chosen by the government outweigh the costs. In this situation, the government would increase its regulatory efforts and punish companies that provide inferior products/services, while companies are also hesitant to take opportunistic actions and ultimately choose to provide high-quality products/services.

When $C_1 - C_2 - DH < 0$ and when $E_g < C_3$, the evolution diagram of government and enterprise is(As shown in Figure 2):

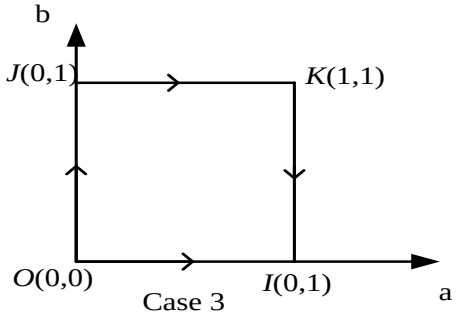

Figure 2: Case 3 of the government enterprise evolution chart

At this point, the evolution of government enterprise cooperation converges to (1,0), that is $C_1 - C_2 < DH$, and the basic benefits of active cooperation chosen by the government are less than the costs. In this situation, companies would choose to provide high-quality products/services, while the government would choose passive cooperation.

When $C_1 - C_2 - D > 0$ and when $E_g > C_3$, the evolution diagram of government and enterprise is(As shown in Figure 3):

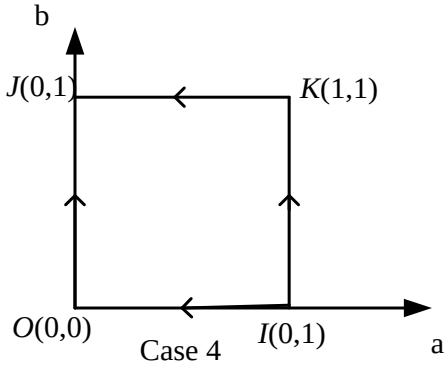

Figure 3: Case 4 of the government enterprise evolution chart

At this point, the evolution of government enterprise cooperation converges to (0,1), which is $C_1 - C_2 > DH$, and the basic benefits of active cooperation chosen by the government outweigh the costs. In this situation, companies would choose to provide inferior products/services, while the government would choose to actively cooperate.

When $C_1 - C_2 - DH > 0$ and when $E_g < C_3$, the evolution diagram of government and enterprise is(As shown in Figure 4):

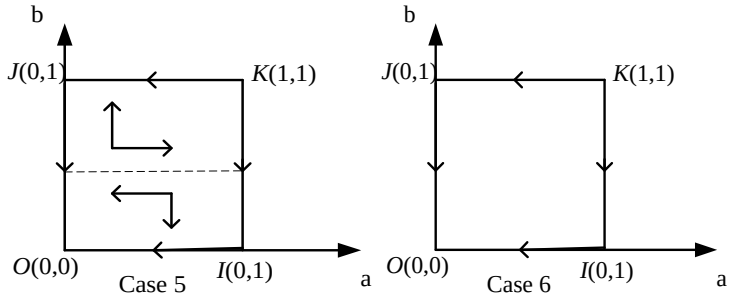

Figure 4: Case 5 and Case 6 of the government enterprise evolution chart

At this point, the evolution of government enterprise cooperation converges to (0, 0), which is $C_1 - C_2 > DH$, and the basic benefits of active cooperation chosen by the government are less than the costs. In this situation, companies would choose to provide inferior products/services, while the government would choose passive cooperation.

3.4. Comparison of the Evolution Results of Government Enterprise Cooperation under Equal Status and Government Dominance

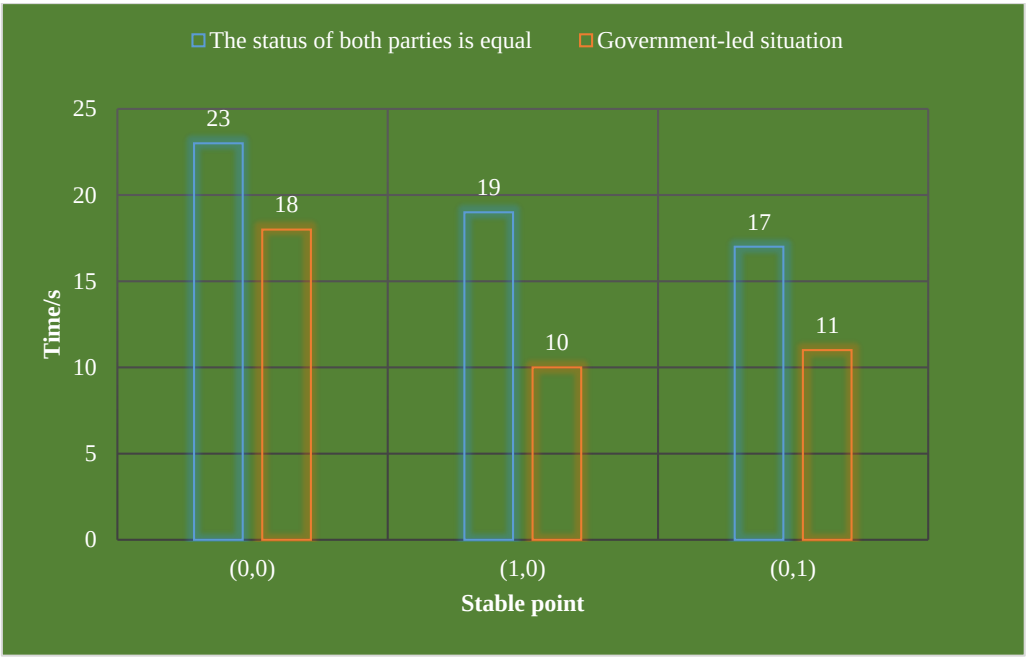

Figure 5: The time when the evolution of government-enterprise cooperation reaches the stable point under the equal status of both parties and the government

In order to verify the stability strategy selection results of both government and enterprise, this article uses MATLAB software to simulate it. This article sets 0.9 as the initial value of y, assigns x values of 0.2, 0.4, 0.6, and 0.8, and finally calculates the time when the evolution of government

enterprise cooperation reaches stable points (0, 0), (1,0), and (0,1) under equal status and government leadership. The statistical results are shown in Figure 5:

Based on the comparison of the two modes of government enterprise cooperation in Figure 5, it can be found that under government leadership, the time for government enterprise cooperation to reach a stable point is shorter than that under equal status between both parties. This means that the government may quickly achieve a certain stable state through strong dominant behavior, thereby objectively promoting the implementation of the project. Enterprises may have problems such as poor financing ability and lack of project management experience. These issues would have adverse effects on project construction, making project progress difficult and unable to achieve expected goals, thereby affecting the public interest. At this point, the government should forcefully intervene, punish, or adjust fiscal policies, so that enterprises can change their strategies and proactively provide high-quality services/products.

3.5. Discussion of Evolutionary Evaluation Results

The stable points under equal status between government and enterprise include (0, 0) point, (1,0) point, (0,1) point, and (1,1) point. Among them, (1,1) point represents that the government chooses the "active cooperation" strategy, while the enterprise chooses the "providing high-quality services/public goods" strategy. Therefore, this is the stable optimal strategy for the evolution benchmark model of government enterprise cooperation. From the comparison of the two modes of government enterprise cooperation, it can be seen that when conducting government enterprise cooperation, it is also necessary to fully consider the strong leading intervention role played by the government in this process. When enterprises have an impact on public interests and have a negative impact on society, in order to ensure project interests and safeguard public rights, the government should give strong leadership, so that both parties' behavior can quickly reach a stable state and ensure project implementation.

4. Conclusions

Based on the systematic review of relevant research, combined with sustainable development theory theory, stakeholder theory and principal-agent theory, this paper studied the impact of environment, social responsibility, corporate governance and other factors on the behavior of government enterprise cooperation, and constructed a benchmark model for the evolution of government enterprise cooperation behavior under the framework of stability strategy. Finally, comparative analysis using numerical simulations was used to calculate the time required for the evolution of government enterprise cooperation to reach a stable state under equal status and government leadership.

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