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Research on the Green Transformation of Mining Enterprises Guided by Government Based on Game Perspective

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Abstract. In order to effectively solve the pollution problem of exploitation and utilization of geological and mineral enterprises and realize the goal of green transformation of geological and mineral enterprises, this paper USES the static game theory to analyze the interactive mechanism between geological and mineral enterprises and the government in the process of green transformation. The results show that the key factors affecting the game behavior are the government's punishment, the supervision revenue, the outside supervision strength and the green transformation cost benefit of the mining enterprises. Based on the results of the study, the paper puts forward some relevant countermeasures and Suggestions to promote the green transformation of geological and mineral enterprises in order to form a good situation of government and enterprise co-governance^[1].

1. Introduction

As a non-renewable resource, mineral resources are not only important strategic reserves, but also making great contributions to the development of China's economy. Since the 18th National Congress of the Party, China's geological and mineral industry has made great progress in transformation and upgrading, but it still faces many new problems. In order to quickly realize the green transformation of mining industry, relevant departments have issued a series of green mine construction standards. In August 2017, the former Ministry of Land and Resources and other six ministries jointly issued "on speeding up the construction of green mines", for China's mining transformation to provide theoretical support^[3]. In April 2018, the Ministry of Natural Resources announced the non-metallic, coal, metallurgy and other nine industries green mine construction standards, Which become the first national green mine construction industry standards^[3]. Therefore, under the green background, it is more and more important to explore the interaction mechanism between government policy and geological and mineral enterprise behavior. However, the green transformation of geological and mineral enterprises has the characteristics of long period and slow effect. It is difficult for enterprises to form spontaneously, and it needs the rewards and punishments of the external environment to regulate it. Therefore, it is of great practical significance to study the game behavior between the government and geological and mineral enterprises.



At present, the domestic research on green transformation of enterprises is more in-depth, but the research on green transformation of geological and mineral enterprises based on game theory is less. Therefore, from the perspective of game theory, this paper analyzes the restrictive relationship between government policy and geological and mineral enterprise behavior, and tries to introduce a long-term mechanism to provide the basis for the green transformation and development of geological and mineral enterprises.

2. Analysis on Influence Mechanism of Green Transformation Development

In 1991, Porter proposed that the government's adoption of appropriate environmental regulation will stimulate the production activities of enterprises, and there is a similar relationship between environmental regulation and green technological innovation. However, with the deepening of the requirements of environmental regulation in China, the relationship between the two is no longer a simple control and control, but a complex multidimensional relationship.

2.1. Characteristics of Government and Mining Enterprises

As the supervisor of the market, the government should take full account of the social interests when carrying out the green transformation, but the government itself is also the main body of rational economy and will pursue its own interests when making decisions. Therefore, in the implementation of green technology, local governments will choose strategies according to the size of regulatory costs. If regulatory costs are within control, that is, government regulation is profitable, the government will actively perform its duties. on the contrary, the government will choose not to supervise. In addition, under the current economic system of China, it is easy for enterprises to realize excess profits, and because of the long-term lack of sustainable development concept, many geological and mining enterprises ignore the damage to the environment in the mining process. Most geological and mining enterprises do not adopt green production mode.

2.1.1. Relationship between Government Regulation and Green Transformation of Geology and Mineral Enterprises.

As the main body of green transformation and development, geological and mining enterprises will carry out technological transformation and upgrading according to their own actual situation, but the ultimate goal of enterprises is to maximize profits and develop green economy with positive externalities. As the guide and supervisor of the development of green economy, the government should formulate corresponding strategies to control, establish appropriate incentive mechanism, and give certain rewards to enterprises that actively develop green economy. Increase the income of geological and mineral enterprises transformation and development, so that enterprises more consciously develop green mining economy.

3. Model Construction and Analysis

3.1. Hypothesis and Construction of Game Model

Assuming that the government and mining enterprises are rational economic entities and the game process is in complete information static state, and the government only has two strategies of supervision and non-supervision, enterprises can only choose to carry out green transformation development or not. The government may reward or punish polluters, but it must pay the costs of inspection. Enterprises will be rewarded if they take the initiative in pollution control. On the contrary, enterprises will be punished by the government if they do not take the responsibility in pollution control, and their behaviors will affect their social image. The indicator for the government to examine the green transformation development of enterprises is the degree of environmental pollution of enterprises. The government can only grasp the status of the green transformation development of enterprises by examining the pollution index of ground mining enterprises.

Assumes that the geological mining cost of green technology innovation for C1,geological mining

enterprises to choose the green production and take benefit brought by the traditional mode of production R_1 and R_2 , respectively, the image of enterprise pollution to bring their own loss of C_i , and corporate governance pollution will get government incentives for X , the government of geological mining enterprise implement inspection costs for C_2 , the government for the geological mining enterprises to carry out supervision and regulation of not the benefits of R_3 and R_4 respectively, H for the local government fines for polluting enterprises. Because C_i is the indirect loss caused by enterprise pollution and cannot be easily quantified in a short time, it is temporarily omitted in the payment matrix of enterprise game^[2]. The setup model is shown in Table 1.

Table 1 Payment Matrix between Government and Mining Enterprises

| | | Government | |
|--------------------|-----------------------------------|------------------------------|------------------------|
| | | Regulatory | Non-regulation |
| Mining enterprises | Developing a green mining economy | $(R_1 - C_1 + X, R_3 - C_2)$ | $(R_1 - C_1 + X, R_4)$ |
| | No green mining economy | $(R_2 - H, H - C_2)$ | $(R_2, 0)$ |

3.2. Game Model Analysis

(1) At $R_1 - C_1 + X > 0$, the profits of geological and mineral enterprises choosing green production mode are higher than those brought by traditional mode production. Nash equilibrium is developing green mining economy and unsupervised, which can realize social benefit to Dahua and benefit both enterprises and society.

(2) when $R_2 - H < R_1 - C_1 + X < R_2$, the situation is relatively complex, that is, the behavior of enterprises is influenced by government strategies. If the government insists on checking the use of green technology in geological and mining enterprises, the optimal strategy of geological and mining enterprises is to adopt green production mode; if the government chooses not to check the strategy, the enterprises will adhere to the original mode of production. The government's behavior is related to the size of its regulatory costs and benefits. If the $H < C_2$, is that the government's regulatory behavior does not bring benefits to it, the government will choose not to supervise because of the profit. If $H \geq C_2$, government and mining enterprises have no optimal strategy, Nash equilibrium does not exist.

(3) When $R_1 - C_1 + X < R_2 - H$, there are two kinds of situations: if the $H < C_2$ is that, the government's regulatory behavior will lose money, the government will choose the non-regulatory strategy, and the geological and mining enterprises will choose not to adopt green technology development, this situation is not conducive to the implementation of the government green economy, not to take; If $H \geq C_2$, Nash equilibrium is doing not develop green mining economy and supervision, there will be government regulatory failure, that is, government supervision does not play a role in the behavior of enterprises, the reason for this situation is that the government supervision is too weak.

From the analysis of the above game results, we can see that the optimal strategy of the game is developing green mining economy and not supervising, that is, the government does not need supervision, and the enterprise takes the initiative to take the responsibility of developing green economy, and achieves the maximum social benefit at this time. And the condition of realizing the equilibrium point is $R_1 - C_1 + X > 0$, that is, the income brought by the green transformation and development of geological and mineral enterprises is higher than that brought by the traditional way of development. Therefore, the government should start with this condition and make relevant policies to ensure the income of geological and mineral enterprises, so as to arouse the enthusiasm of green transformation and development of geological and mineral enterprises.

4. Conclusion and suggestion

It can be seen from the above analysis results that, in the incomplete information state, the enterprise's own costs and benefits, the government's supervision and external public supervision will affect the enterprise's behavior, so the government should formulate corresponding policies to urge and guide the

geological and mining enterprises to carry out transformation and development. Based on the above analysis results, this paper proposes the following Suggestions:

(1) We will innovate governance models and improve oversight mechanisms., according to the results of this analysis on whether the government's actions directly affect the enterprise green development, therefore the local government should formulate corresponding policies, such as according to the degree of scarce resources, establishing the paid use system, the third party supervision incentive policy, to realize normalization and institutionalization of the third party supervision, increase the cost of pollution of mining enterprises. At the same time, the government should constantly improve the governance model, abandon the traditional "one size fits all" governance model, classify and group the geological and mining enterprises in the same region according to the actual operation status of enterprises, and establish the responsibility sharing mechanism within the group, so as to force the geological and mining enterprises to carry out green production.

(2) Increase publicity, pay attention to incentive and guidance. It can be seen from the above game results that it is difficult for the mining enterprises to spontaneously transform and develop. Therefore, the government should carry out various forms of green education activities to make the mining enterprises realize the importance and inevitability of transformation and development. In addition, the government should further improve the regional ecological compensation mechanism, broaden the ecological compensation fund channels, and realize the purpose of spontaneous transformation of enterprises. At the same time, the government should actively reduce excess production capacity, eliminate small mining areas with high pollution, give play to the role of advanced enterprises in promoting green development, and promote green transformation and upgrading of geological and mining enterprises.

(3) We will increase investment in science and technology research and development to help enterprises develop in a green way. The main factors that hinder the transformation of mining enterprises are technology and cost, so mining enterprises should take this as the entry point. First of all, geological and mining enterprises should increase investment in green technology research, promote industrial transformation and upgrading, and pay attention to the construction of recycling projects such as resource recovery and remanufacturing. At the same time, enterprises should also pay attention to the intelligent construction in the mining area, introduce integrated green production equipment, achieve efficient and clean production in the mining area, reduce the production cost of enterprises. Secondly, enterprises should pay attention to the cultivation of talents in key positions, regularly invite experts to carry out technical training on key positions, ensure that employees in key positions can master green production technology, and strive to reduce environmental pollution from the source.

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