Game Analysis between Governments in Collaborative Management of Carbon Sequestration in Inter-regional Grassland

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Abstract. With the initiative and implementation of Belt and Road, as well as the promotion of "Green Belt and Road", the economic and environmental links between the six provinces are increasingly close. However, due to the great differences in the development of natural economic conditions and social economic conditions in different provinces and regions, the grassland ecological compensation standard and the grassland carbon sink management measures are different, which makes the grassland carbon sequestration capacity different. In view of the continuity of grassland space, it is necessary for governments, enterprises, non-profit organizations and herdsmen in different regions to take effective measures to manage grassland carbon sinks in a coordinated manner. The sustainable development of grassland ecological environment can be realized at the same time of improving carbon sequestration capacity of grassland. Therefore, the leading role of the government in the cross-regional cooperative management of grassland is particularly important. From the point of view of game theory, this paper analyzes the choice of game behavior between central government, local government and local government, and puts forward corresponding policy suggestions.

Introduction

Our country has a vast grassland area, natural grassland area of about 392.8 million hectares, accounting for the world's prairie area of 12, ranking first in the world. Steppe and forest, contain rich carbon storage and very strong carbon sink function. At present, the grassland carbon storage in China is about 42.73 billion tons, which accounts for 7.5% of the world grassland carbon storage. The promotion of green "Belt and Road" pays more attention to the development of ecological environment in the provinces along the line, but the grassland ecological environment of the provinces along the line is seriously damaged, and the effect of grassland ecological environment management is not obvious. So that the grassland carbon sink function has not been well developed and utilized. On the one hand, the coordinated management of carbon sinks across the grasslands is aimed at developing rich reserves of carbon sinks in grassland, giving better play to the economic and ecological functions of grassland carbon sinks, and realizing the goal of energy saving and emission reduction in China. On the other hand, the grassland ecological environment can be managed effectively and the sustainable development of grassland ecological environment can be realized. This article will carry on the game analysis to the government level cooperation party.

Analysis on the current situation of coordinated Management of carbon sequestration in Trans-regional grassland

In view of the spatial and externality characteristics of grassland ecological environment, it is difficult to realize the development and utilization of grassland carbon sink only by one government. At present, China has not carried out relevant work on the management of carbon sinks in
the grasslands across regions. It is limited to the cooperative management of government departments, ecological enterprises, polluting enterprises, non-profit organizations, scientific research institutions, universities and herdsmen in the region. Moreover, the degree of synergy between relative synergetic parties is relatively weak. The coordination and cooperation among governments, enterprises, herdsmen, non-profit organizations and scientific research institutions are needed in the coordinated management of carbon sinks within the region as well as in the inter-regional grassland carbon sink management. And the government is in a dominant and leading position. The difference is that the central government is needed to guide and participate in the coordinated management of cross-regional grassland carbon sinks. This requires central and local governments to play a leading role in promoting the implementation of coordinated management of carbon sinks across the grasslands.

**Synergetic subject Analysis of carbon sequestration Management in Trans-regional grassland**

**Central Government departments**

There are more synergetic parties in cross-regional steppe carbon sink management than in regional grassland carbon sink cooperative management. In the coordinated management of carbon sinks across the grasslands, the main level of government involves not only the local governments in the region, but also the local governments and the central government outside the region. The central government plays a leading role in the coordinated management of carbon sinks across the grasslands, which represents the overall interests of the country and society, and is based on the goal of national energy conservation and emission reduction and the sustainable development of human society. In the coordinated management of carbon sinks across the grasslands, the central government's main responsibility is to supervise and manage the local governments, to punish the local governments for actions that harm the overall interests of the region, and to ensure that the local governments attach great importance to the whole of the regions. Instead of pursuing the interests of the region in a one-sided way.

**Local Government departments**

The local governments, proceeding from the economic and social interests of the region, play the role of cooperating with the central government and other local governments in the management of carbon sequestration in the trans-regional grassland, and leading regional enterprises, non-profit organizations and herdsmen. Therefore, local governments have a variety of tasks and responsibilities in the coordinated management of carbon sinks in the cross-regional grasslands. The cooperative management among local governments is prone to the "prisoner dilemma" caused by asymmetric information, even if the interests of the local and regional interests are damaged, so the central government needs more supervision and restriction. The game analysis between central government, local government and local government is carried out to find out that the main factors that affect the choice of government strategy are the key to implement the coordinated management of carbon sinks across the grasslands.

**Game Analysis between governments in Collaborative Management of carbon sequestration in Inter-regional grassland**

**Game Analysis between Central Government and Local Government**

It is assumed that the central government and the local government do not consider the influence of other collaborators, that is, the game players only have the central government and the local government, and based on the assumption of "rational people", that is, the two sides pursue the maximization of their respective interests. The action strategy of the local government is to participate in the cooperative management of the grassland carbon sink or not to participate in the cooperative management of the grassland carbon sink, and the central government's action strategy is to supervise or not supervise the cooperative management of the grassland carbon sink in which the local government participates. Assume that the cost of central government to participate in the coordinated management of carbon sinks across the grassland is C1, and the probability of central government...
supervision is \( a \); The cost of local government participating in the cooperative management of grassland carbon sink is \( C_2 \), and the probability of local government actively participating in the cooperative management of grassland carbon sink is \( b \); The probability that the local government did not participate in the coordinated management of the carbon sinks in the grasslands and was found by the central government was \( r \), and the fine imposed by the central government on the local governments who did not participate in the cooperative management of the grassland carbon sinks was \( T \) (\( T > C_2 \)). The static game decision matrix of figure 1 can be obtained:

<table>
<thead>
<tr>
<th>Administration</th>
<th>local government</th>
</tr>
</thead>
<tbody>
<tr>
<td>supervise ( a )</td>
<td>(-C_1, -C_2)</td>
</tr>
<tr>
<td>no regulation ( 1-a )</td>
<td>(0, -C_2)</td>
</tr>
</tbody>
</table>

In the static game decision matrix between central government and local government, when \( T < C_2 \) or \( rT < C_1 \), the cost of local government participating in the cooperative management of grassland carbon sink is higher than the penalty imposed by central government or the cost of supervising local government. It will lead local governments to choose to pay fines rather than actively participate in the coordinated management of grassland carbon sinks, and the central government will choose not to regulate local governments because of cost pressure. Suppose that the central government's expected return function \( W(a, b) \) and the local government's expected return function \( G(b, a) \) are:

\[
W(a, b) = a[-C_1b + (rT - C_1)(1 - b)]
\]

(1)

\[
G(b, a) = b[-C_2a - C_2(1 - a)] + (1 - b)(-rT \cdot b)
\]

(2)

The first order derivative of the two formulas is obtained, and the extreme point is obtained, and the Nash equilibrium condition of the mixed strategy is obtained. Solution: \( b = 1-C_1 / rT \); \( a = C_2/rT \). The Nash equilibrium solution of mixed strategy is obtained: local government \((C_1/rT, 1-C_1/rT)\); administration \((1-C_1/rT, C_2/rT)\).

Game Analysis between Local governments in Collaborative Management of carbon sinks in Trans-regional grassland

Model construction: game sides: local government M, local government N. The main players of the game, M and N, are assumed to aim at maximization of their own interests; M and N did not consider the influence of the central government on the behavior strategy. Strategic behavior selection: M and N's choice of strategic behavior is: cooperation, non-cooperation; The order of the game between the two governments is as follows: M and N makes the choice at the same time; Income: if M and N both choose to cooperate, then each side gains 5; If M chooses to cooperate and N chooses not to cooperate, M will suffer more losses because N does not cooperate, and N will gain more benefits as a result. At this time, the income of M and N is -10/10; In the same way, when M chooses not to cooperate and N chooses to cooperate, the profit of M and N is 10/10; When M and N both choose not to cooperate, governments will fall into a "prisoner's dilemma" situation, which will reduce the benefits of both sides. At this point, the benefits of M and N are as follows: -5/-5. Thus, the static game decision matrix of figure 2 can be obtained:
From the static game decision matrix among local governments, we can know that in the cooperative management of carbon sinks in the inter-regional grassland, the behavioral strategy choices made by the regional governments are based on the strategic choices of other regional governments. It is the best choice to consider the influence of self-strategy and counterparty strategy on its income. There are two kinds of behavior strategies for M and N: cooperation and non-cooperation. When N makes the choice of cooperative strategy behavior, M chooses not to cooperate according to the principle of individual rationality, because the profit 5 is less than 10. When N chooses not to cooperate, M still chooses not to cooperate, so the profit of -10 is less than -5. Therefore, the best policy for M is not to cooperate, because no matter what kind of strategy N makes, M chooses not to cooperate to ensure that its income is maximized. By the same token, it is also the best policy for N not to cooperate. The final result is that both governments choose not to cooperate, and the benefit of the game is -5 and -5.

**Countermeasures and suggestions for the development of coordinated management of carbon sinks across the grassland**

The establishment of the cooperative management mechanism of carbon sinks across the grassland requires the central government to play a guiding role and the active participation and cooperation of local governments. Based on the above game model analysis, the supervision and punishment of central government, the participation cost of local government and the local government will affect the development of the coordinated management of carbon sink in the trans-regional grassland. The following measures and suggestions will be put forward from the two angles of central government and regional local government on the coordinated development of carbon sinks in cross-regional steppe.

**Increased regulation and penalties to increase costs of violations**

The major prairie provinces involved in the carbon sequestration of interregional steppe are mainly in the area of animal husbandry economy, so it is inevitable that the region only pursues the economic growth and ignores the deterioration of the grassland ecological environment. Due to the small number of environmental monitoring stations in many places, the distribution is unreasonable. In order to have an intuitive and clear understanding of the whole grassland ecological environment, it is necessary to increase the density of environmental monitoring stations and increase the number of grassland ecological and environmental monitoring stations in various regions. At the same time, according to the monitoring results of the grassland ecological environment, the local governments that have failed to manage the grassland ecological environment and made the grassland ecological environment worse are held accountable. Especially for those who do not carry out grassland environmental governance and do not participate in the grassland carbon sink cooperative management, increase their penalties, increase the local governments do not carry out grassland carbon sink coordination management costs, It is forced to participate actively in the coordinated management of carbon sinks in cross-regional steppe.

**Raise ecological compensation standards and reduce participation costs**

The cost of local governments participating in the coordinated management of carbon sinks across the grasslands is the main factor affecting the choice of government strategies. The lower the cost of local government participation in cooperative management, the greater the probability b of
participating in cooperative management of grassland carbon sinks. The central government can set up special funds for grassland ecological compensation, perfect the grassland compensation mechanism, raise the grassland ecological compensation standard for local governments, and reduce the cost of local governments participating in the cooperative management of grassland carbon sinks. Carbon trading has attracted more and more attention at home and abroad, and carbon sink prices are also rising. The central government can adjust the grassland ecological compensation quota for local governments according to the price changes of carbon trading market. The increase of compensation amount of grassland carbon sink can effectively reduce the cost of local government participating in the cooperative management of carbon sink across the grassland and improve its enthusiasm for participation.

Establishment of a platform for sharing information on carbon sinks in grasslands between local governments

From the game model between local governments, we can see that there is a "prisoner's dilemma" between governments, and the main reason for this phenomenon lies in the asymmetry of information between governments. Therefore, they all make strategic choices that are most beneficial to themselves, and affect the long-term and overall interests of the region. The local government should make full use of the existing network resources to realize the sharing of grassland ecological environment management information in the region. It can effectively monitor and manage the grassland ecological environment governance situation in the whole region by constructing the information sharing mechanism of carbon sink in the grassland across the region. The establishment of a unified dynamic information database of grassland carbon sinks can enable all regions and departments to communicate with each other and form a good communication situation. At the same time, it can effectively alleviate the phenomenon of prisoners' dilemma caused by asymmetric information.

Conclusions

From the income function of the central government and the local government, we can see that the central government has stepped up the supervision and punishment of the local government and raised the ecological compensation standard for the local government. It can effectively increase the cost of violation and reduce the cost of participation of local governments, thus promoting the implementation of coordinated management of carbon sinks across the grasslands.

Through the analysis of the static game decision matrix among local governments, it can be seen that in the process of realizing the cooperative management of carbon sinks across the grasslands. If the local governments communicate actively through the grassland carbon sink information sharing platform, it will promote the development of cross-regional grassland carbon sink cooperative management.

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References

