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Game Research on Risk Sharing of Rural Tourism Construction Projects

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Abstract: *Rural tourism is an important starting point for industry to promote rural revitalization. After analyzing the risks that may be faced in the process of rural tourism construction projects, this paper introduces the dynamic game theory to establish a decision-making model for the optimal sharing ratio of shared risks in rural tourism PPP projects, and obtains the optimal Nash equilibrium solution of the model to determine the optimal ratio of risk sharing between the government and the tourism project contractor. The results show that in the dynamic game of risk sharing of rural tourism PPP projects with priority bidding by the government, the degree of information asymmetry, the loss coefficient of negotiation and the unequal status of the two parties will directly affect the optimal sharing ratio of risk sharing. Therefore, in the process of rural tourism construction, the government should publicize more information, and choose local enterprises. Construction enterprises also need to understand the relevant situation of the project from various aspects, so as to reduce information asymmetry.*

Keywords: *Incomplete information dynamic game, Rural tourism, Risk analysis*

1. Introduction

The Nineteenth National Congress of the Communist Party of China put forward the strategic goal of rural revitalization, and General Secretary Xi Jinping further summarized the general requirements of rural revitalization as "prosperous industries, livable ecology, civilized rural customs, effective governance, and affluent life." Among them, “industrial prosperity” as the leading position is the economic basis for the development of rural society, which can promote the flow of urban and rural factors, thus promoting rural revitalization and realizing the overall development of urban and rural structure. In order to achieve industrial prosperity and achieve the goal of rural revitalization, the tourism industry has become the main force of rural revitalization industry with its large space for poverty alleviation, wide driving range and strong comprehensive benefits. Rural tourism is in full swing. Data show that the number of receptions for leisure agriculture and rural tourism in China has risen steadily from 2011 to 2019, with a peak of 3.09 billion people in 2019. Although 2020 was forced to press the pause button due to the epidemic, from January to August 2020, the number of receptions still reached 1.207 billion people, and the income of leisure agriculture and leisure agriculture and rural tourism reached 592.5 billion yuan. The existing research also proves the positive role of rural tourism in rural revitalization, rural tourism can activate the existing rural resources and respond to the rural revitalization strategy in an all-round way[1]. As a new form of tourism integrating primary, secondary and tertiary industries, rural tourism can be used as a characteristic path of targeted poverty alleviation, which is of great value in promoting the construction of beautiful countryside and increasing farmers' income[2].

At the same time, various problems in the development of rural tourism have also emerged. For example, Chen Tianfu[3] took Henan Province as an example, pointing out that Henan Province has light quality in the process of developing rural tourism, and there is a problem of product homogeneity, ignoring long-term environmental benefits, attaches great importance to resource development but lacks corresponding basic supporting facilities; Huang Zhenfang et al[4] through the examination and reflection of rural tourism, pointed out that the development of tourism will face the decline of environmental quality, homogeneous competition in tourism, damage to rural culture, insufficient industrial cultivation, capital and talent shortages, outdated operating models, and dislocation of land use. Scholars have mentioned many times that there are problems in the development process of tourism projects, such as repetition, high degree of homogeneity, lack of characteristics, failure to organically integrate with local social culture, and shortage of operating capital to solve. Throughout the literature, there are few

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literatures that mention the rationality analysis of the pre-development stage of rural tourism or the risk allocation in the construction of rural tourism projects. As a typical systemic industry, the tourism industry needs to build the tourism area as a whole when developing, and the investment cost is relatively high. In order to realize the overall revitalization of the countryside, the government should take into account people's livelihood while developing rural tourism and exploiting tourism resources, improve infrastructure and basic service capabilities, and improve the convenience of production and life satisfaction of local villagers. The ability to attract investment has put forward higher requirements. The government needs to use private capital to attract investment and jointly revitalize the project.

The project of government and social capital cooperation, also known as public- private-partnership-PPP project, PPP model has been widely used in the research of urban infrastructure in China, such as Beijing Metro Line 4 project, Nanning Nakao River project and Yiyang City Domestic Waste Incineration Project, etc. Scholars have used the method of game theory to analyze the risk sharing problem in PPP projects in detail. For example, Zhang Jianjun et al[5] established static game models of complete information and incomplete information for PPP projects, and Li Yan[6] based on different bidding orders of participants, Shao Jianglu[7] based on the perspective of incomplete information, Su Hui et al[8] conducted a dynamic game study on the risk sharing of PPP projects under the condition of unequal status of the participants. Compared with the construction of urban infrastructure projects, rural infrastructure PPP projects have a weaker foundation, a longer construction period, a large demand for project funds and fewer sources of funds, and there are higher risks[9]. Most of China's beautiful areas overlap with poor and remote areas. During project construction, there are problems such as inconvenient transportation, development difficulties, relatively short funds, long construction period, and difficulty in integrating village customs and culture. This poses more challenges to the construction of rural tourism PPP projects. Therefore, it is more urgent and arduous to conduct research on risk sharing in the construction of rural tourism projects. Therefore, this paper uses the method of game theory to establish the risk allocation plan and risk sharing ratio decision-making model in the construction stage of rural tourism projects, hoping to further improve the research on rural tourism.

2. Analysis of risk sharing dynamic game model

The main participants in the construction of rural tourism projects are the local government, the contractors of tourism projects and farmers. Because the status of farmers in rural tourism is mainly reflected in the land and housing providers, and their behavior is largely affected by the government's propaganda and the surrounding farmers. The leading role lacks sufficient rational thinking, so the risk-taking responsibility of farmers is not considered in the construction stage of tourism projects. Therefore, the two sides of the game in this paper are local government departments and tourism project contractors.

Incomplete information means that at least one player in the game does not fully know the benefit function of some other players. In the above game process, the government has more and more detailed information on tourism resources. At the same time, as a policy maker, it will be in an information advantage position in the game process, while the tourism project contractor is in an information disadvantage position. Due to the differences in the risk-taking capacity and the upper limit of the risk that the government and the enterprise can bear, the proportion of shared risks needs to be negotiated many times before reaching an agreement. In order to analyze the game under the condition of incomplete information, Harsanyi proposed in 1967 a method of converting incomplete information into complete but imperfect information on the basis of transforming ignorance of benefits into ignorance of types. The idea of analysis is the Harsanyi conversion. The specific conversion method is to introduce a virtual "natural" player, extract their respective types before choosing the actual player in the game, and let each actual player know their own type, but not let the player know The types of other game players only know the probability distributions of various types[10].

Specifically, risks in the construction of rural tourism include blindly starting the project without conducting a feasibility analysis, breaking the capital chain during the construction process due to limited rural finance, and the construction environment in rural areas is relatively complicated, so it is necessary to coordinate with the villagers and provide support There is a shortage of facilities, and higher requirements are placed on project design.

Assuming that the local government department and the contractor of the tourism project share a risk in the rural tourism construction project, the government department bids first and may transfer the risk it should have assumed to the contractor of the tourism project. If the contractor of the tourism project

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accepts this Prices are negotiated. If the tourism project contractor rejects the bid from the government department, it will enter the second round. The government is eager to introduce social capital and negotiate with the enterprise. The enterprise can redistribute the risk bearing ratio, and the enterprise will continue to bid. If the government department accepts the enterprise If the government department rejects the enterprise's bid, it will continue to enter the third round, and so on, until one party accepts the other party's bid, the negotiation ends.

2.1 Basic assumptions of the model

Hypothesis 1: The government department G of the participating party and the contractor T of the tourism project are both rational people. Both parties hope to reach a negotiation. The government wants to increase its influence and complete political achievements.

Hypothesis 2: The risks in rural tourism construction PPP projects are independent and not related;

Hypothesis 3: The information between the two parties is asymmetric, that is, one party cannot fully understand the other party's action choices and benefit functions;

Hypothesis 4: For a certain risk, the government department's risk sharing ratio in the i-th round of negotiation is r_i, then the tourism project contractor's share ratio is $(1 - r_i)$, that is, the tourism project contractor bargains for r_i;

Hypothesis 5: In the game process, the government department in a strong position gives priority to the proportion of shared risks that it is willing to bear, and may transfer the risks that should have been borne by itself.

2.2 Discussion of model parameters

Risk transfer share and probability. The government department will use its own strong position to carry out additional transfer of part of the risk. The part of the risk transferred in each round is recorded as α_i, and the probability of risk transfer is recorded as q. Then the probability of risk transfer without a strong position is 1- q.

Negotiate attrition factor. In each round of bargaining negotiations, there will be cost consumption, including explicit costs and implicit costs. The more times the two parties negotiate, the higher the costs will be. In the actual PPP project, due to information asymmetry and time cost differences between the two parties, the respective attrition coefficients of the negotiations between the two parties are also different. In actual projects, the negotiation expenditure of government departments is smaller than that of tourism project contractors. Therefore, use β_1 and β_2 ($\beta_1 < \beta_2$) to denote the negotiation loss coefficients of government departments and tourism project contractors, respectively.

2.3 Game model

First round. The government department first bids, the government department proposes that the risk it will bear is r_1 and the risk that the tourism project contractor will bear is $1- r_1$, in addition, the government department has a q probability of transferring the risk that it should have borne partially, and the risk part of the transfer is α_1, at this time, the risk borne by the government department and the tourism project contractor are:

$$G_{11} = q\,(r_1 - \alpha_1) \quad (1)$$

$$T_{11} = q\,(1 - r_1 + \alpha_1) \quad (2)$$

When the government department does not transfer the risk to the tourism project contractor with a probability of 1-q, the risk borne by the government department and the tourism project contractor is:

$$G_{12} = (1 - q)\,r_1 \quad (3)$$

$$T_{12} = (1 - q)\,(1 - r_1) \quad (4)$$

Therefore, in the first round, the expectations of government departments and tourism project contractors to bear risks are:

$$G_1 = G_{11} + G_{12} = q\,(r_1 - \alpha_1) + (1 - q)\,r_1 \quad (5)$$

$$T_1 = T_{11} + T_{12} = q\,(1 - r_1 + \alpha_1) + (1 - q)\,(1 - r_1) \quad (6)$$

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In the first round, if the tourism project contractor accepts the offer from the government department, the negotiation is reached and ends here, and if the tourism project contractor rejects the bid from the government department, the second round is entered. Second round. This time, the tourism project contractor first bid, proposed that the risk part that the government department needs to bear is r_2, the risk part borne by itself is 1 - r_2, the government department still has the probability of q using its strong position to transfer the risk to the tourism project contractor, the risk part of the transfer is α_2, a series of costs occur in the negotiation process, the longer the negotiation time, the higher the cost, therefore, from the second round to add the consumption coefficients β_1 and β_2 of the government department and the private party. The risks to be borne by government departments and private parties are:

$$G_{21} = \beta_1 q (r_2 - \alpha_2) \quad (7)$$

$$T_{21} = \beta_2 q (1 - r_2 + \alpha_2) \quad (8)$$

When the government department does not transfer the risk with a probability of 1-q, the risk borne by the government department and the tourism project contractor is:

$$G_{22} = \beta_1 (1 - q) r_2 \quad (9)$$

$$T_{22} = \beta_2 (1 - q) (1 - r_2) \quad (10)$$

In the second round, the expectations of government departments and tourism project contractors to take risks are:

$$G_2 = G_{21} + G_{22} = \beta_1 q (r_2 - \alpha_2) + \beta_1 (1 - q) r_2 \quad (11)$$

$$T_2 = T_{21} + T_{22} = \beta_2 q (1 - r_2 + \alpha_2) + \beta_2 (1 - q) (1 - r_2) \quad (12)$$

In the third round, the expectations of government departments and tourism project contractors to bear risks are:

$$G_3 = G_{31} + G_{32} = \beta_1^{\,2} q (r_3 - \alpha_3) + \beta_1^{2} (1 - q) r_3 \quad (13)$$

$$T_3 = T_{31} + T_{32} = \beta_2^{\,2} q (1 - r_3 + \alpha_3) + \beta_2^{2} (1 - q) (1 - r_3) \quad (14)$$

In the third round, if the tourism project contractor accepts the bid of the government department, the negotiation ends, if the tourism project contractor rejects the bid of the government department, the next round is entered, and the game process between the two parties is so on, until one party accepts the other party's bid and agrees on the proportion of risk allocation.

Solve the established model. First, the Harsanyi transformation theory is used to transform the dynamic game under incomplete information conditions into a dynamic game under complete but imperfect conditions, and it should be clear here that for infinite rounds, the reverse point does not affect the results of the model in several rounds[11]. If the bid of the tourism project contractor in the second round is greater than the risk expectation value G3 of the third round, the government department will reject the bid of the tourism project contractor and enter the third round. Therefore, in order to reduce the cost of negotiation, the optimal strategy should be:

$$G_2 = G_3, \text{ which means } \beta_1 q (r_2 - \alpha_2) + \beta_1 (1 - q) r_2 = \beta_1^{\,2} q (r_3 - \alpha_3) + \beta_1^{2} (1 - q) r_3 \quad (15)$$

$$\text{And thus get: } r_2 = q\alpha_2 + \beta_1\alpha_3 - \beta_1 q\alpha_3 \quad (16)$$

At this time, the risk expectations of the tourism project contractor are:

$$T_2 = \beta_2 + \beta_2\beta_1 q\alpha_3 - \beta_2\beta_1 r_3 \quad (17)$$

$$T_3 = \beta_2^{\,2} + \beta_2^{2} q\alpha_3 - \beta_2^{\,2} r_3 \quad (18)$$

$$\text{Compare the two: } T_2 - T_3 = \beta_2 [1 - \beta_2 + (\beta_1 - \beta_2) (r_3 - q\alpha_3)] \quad (19)$$

From $1 < \beta_1 < \beta_2$, $0 \le \alpha_3 \le r_3 \le 1$, $0 \le q \le 1$, T2 < T3 can be derived, that is, the tourism project contractor bears less risk in the second round than in the third round. Therefore, the two sides will not enter the third round.

Similarly, if the first round is reversed and the government department proposes a risk sharing ratio of R1, the optimal strategy of the participants is:

$$T_1 = T_2, \text{ which means } q (1 - r_1 + \alpha_1) + (1 - q) (1 - r_1) = \beta_2 + \beta_2\beta_1 q\alpha_3 - \beta_2\beta_1 r_3 \quad (20)$$

The result is:

$$r_1 = 1 + q\alpha_1 - \beta_2 (1 + \beta_1 q\alpha_3 - \beta_1 r_3) \quad (21)$$

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Since the reverse point does not affect the outcome of the game no matter how many rounds it is set, so:

$$r_3 = r_1 = 1 + q\alpha_1 - \beta_2 (1 + \beta_1 q\alpha_3 - \beta_1 r_3) \quad (22)$$

$$\text{yields } r_3 = [\beta_2 - 1 + q(\beta_1\beta_2\alpha_3 - \alpha_1)] / (\beta_1\beta_2 - 1) \quad (23)$$

$$1 - r_3 = [\beta_1\beta_2 - \beta_2 q(\beta_1\beta_2\alpha_3 - \alpha_1)] / (\beta_1\beta_2 - 1) \quad (24)$$

Let the α be constant, and the sub-game refined Nash equilibrium solution of this infinite round bargaining game model can be obtained as:

$$r^* = (\beta_2 - 1) / (\beta_1\beta_2 - 1) + p\alpha \quad (25)$$

$$1 - r^* = (\beta_1\beta_2 - \beta_2) / (\beta_1\beta_2 - 1) - p\alpha \quad (26)$$

This sub-game refines the Nash equilibrium to the nominal risk ratio of government departments and tourism project contractors, and the actual risk ratio is $(\beta_2 - 1) / (\beta_1\beta_2 - 1)$and $(\beta_1\beta_2 - \beta_2) / (\beta_1\beta_2 - 1)$.

3. Conclusion

The analysis of the incomplete information dynamic game of participants in the construction of rural tourism PPP projects shows that the size of the negotiation loss coefficient, the inequality of status and the degree of information asymmetry between the government and enterprises determine the optimal sharing ratio of shared risks.

Based on this, this paper proposes the following: the public sector should create a fair and orderly cooperation atmosphere, and at the same time actively improve its own credit, reduce the incentive to transfer risks to construction enterprises, and increase the enthusiasm of enterprises to participate in rural tourism construction projects. In the process of project publicity and bidding, the government should disclose as much detailed information as possible that can be made public, reduce the degree of information asymmetry, communicate and coordinate with villagers in advance, and reduce resistance in the process of project construction; Contractors should pay attention to policy trends, respond to the call of the state, understand the goals and missions of government departments in initiating the construction of rural tourism PPP projects, actively achieve effective communication with the public sector through multiple channels and methods, and reduce their own negotiation costs in the game. Rural tourism construction projects have strong regional differences, which require a certain degree of understanding of local tourism resources, and should focus on local enterprises in attracting investment and give full play to the advantages of local familiarity with the environment.

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