Research on Risk Sharing Mechanism of Power Materials Project under Incomplete Contract Environment

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Abstract. Due to large capital investment and good economic benefits, power infrastructure projects are suitable for project financing. The repayment guarantee of project financing comes from the project itself rather than the guarantee provided by the guarantor. Therefore, the risk sharing mechanism in project financing is particularly important. This paper proposes that due to the existence of bounded rationality, transaction cost and information asymmetry, the contract of financing of power infrastructure projects is incomplete. According to this condition, the risk sharing mechanism between the actual investors of the project and the project loan bank is established; The asymmetry situation constructs a risk-sharing bargaining game model with incomplete information, calculates the respective risk-bearing ratios of both parties, and provides a basic conclusion for the future financing model of power infrastructure projects.

1. Introduction

Globally, project financing has become an effective financing model, which is mainly used in resource development projects, infrastructure construction projects, and manufacturing projects. The construction period of electric power infrastructure projects is long. The model for raising funds for the construction of large-scale engineering projects has gradually matured. Incompleteness, focusing on the risk sharing mechanism of project financing in the application of power infrastructure projects, discusses the bargaining game model of risk sharing between the actual investors of the project and the loan banks of the project. To make better use of funds for the future, lay the foundation for the development of power infrastructure through financing.

2. Incompleteness of financing contract for power infrastructure projects

The financing of power infrastructure projects has the characteristics of different nature of partners, long cooperation period and complex risk distribution. Therefore, the contract is always incomplete. First of all, due to the limited rationality of the participants, the complex external environment, project specificity and other uncertainties, it is impossible for the project participants to write all the information related to the contract beforehand, and it is impossible for the future to happen. The things are predicted one by one. Secondly, the contract period of the power infrastructure project is relatively long. When the costs of the transaction and negotiation of the project participants are positive, the contract participants have a higher cost for detailed requirements. Finally, the interests of the various parties involved in the project are highly differentiated, and the observation and supervision of the behavior of other participants can lead to endogenous information asymmetry.
In the financing of power infrastructure projects, the main body of risk sharing is the actual investors of the project and the loan banks of the project. In project financing, the actual investor of the project plays a vital role. It not only owns part or all of the equity of the project company, but also the project loan bank requires the actual investor of the project to build and operate the project in the form of mortgage guarantee. Provide credit support. At the same time, due to the complicated financing structure of power infrastructure projects, the financing documents will inevitably be very complicated, including various guarantees, mortgages, contracts and a series of debt ratio restrictions. In the negotiation stage, the two parties will negotiate the responsibilities and obligations that the actual investors of the project need to undertake during the project financing process, and at the same time determine the nature, amount and time requirements of the guarantees that the actual investors need to provide through negotiation.

3. Design of Risk Sharing Mechanism in the Financing of Electric Power Infrastructure Projects

This paper uses game theory to study the design of the financing risk sharing mechanism of power infrastructure projects under the condition that the participants in the financing of power infrastructure projects are asymmetric, especially when the project's loan banks occupy a strong position.

(A). Model hypothesis

Hypothesis 1: In the negotiation, both the project loan bank B and the project investor I maintain sufficient rationality, and both parties hope to reach a cooperation through negotiation;

Hypothesis 2: Interactions that do not occur between risks in the project;

Hypothesis 3: For a certain risk, the risk assumed by the project investor is \( k_i (0 \leq k_i \leq 1) \) (where \( i \) is the number of rounds of the game), then the risk of the project loan bank is \( 1 - k_i \), and the two parties start bargaining for \( k_i \). The game.

Hypothesis 4: The bargaining game is an incomplete information game. The project loan bank and the project investor are not very familiar with the other party's characteristics and strategy choices. Therefore, the two parties do not know the other party's strong position in the negotiation.

(B). Model parameter

(a). Negotiating the loss factor. The negotiating loss factor \( \Theta (>1) \) is the most important parameter in the model. The negotiating loss factors for project loan banks and project investors are \( \Theta_1 \) and \( \Theta_2 \), respectively. It refers to the cost consumed by the two parties in the bargaining process, including the time cost, labor cost, information cost and resulting opportunity cost of the cooperation between the two parties. The size is determined by time, manpower and economy. Other factors determine. When negotiating, each side of the game of one round will require more negotiation costs. In the actual financing of power infrastructure projects, the status of project investors and loan banks is asymmetric. The loan banks of the project have more information and resources, so the negotiation cost is usually smaller than the actual investors of the project, ie \( \Theta_1 < \Theta_2 \) for each round of negotiation, the project investors will spend more on negotiation costs.

(b). The asymmetry of status. In the bargaining game, the lending bank and the investor have different levels of resources and information, and the party with more resources and information will have an advantageous position in the negotiation, which is the asymmetry of the status of the two parties. The party with a strong position in risk sharing will be in a state of deterrence in risk negotiations, which will force the other party to accept the additional risk of their transfer. In the financing of power engineering projects, the project's loan bank will provide funds for the project, and will require the project's investors and third parties to provide a variety of credit guarantees, and the project's loan bank will follow the project's economic benefits. Therefore, the loan bank of the project is in a dominant position. In the risk sharing negotiation, the project loan bank has a strong position in risk sharing relative to the investor. In the process of bargaining negotiation, the project loan bank will force the project investor to accept the transfer. A certain percentage of the risk, this ratio is expressed by \( \mu \). Because the risk share of the loan bank transferred to the investor in each round game is not greater than its own risk, the value range of \( \mu \) is \( 0 < \mu < k_i < 1 \).
(c). The probability that a project investor will adopt a strong position strategy. In the incomplete information game, the participants do not fully understand the cost of the game, the characteristics of the other party, and the strategies that may be adopted. In the financing of the power infrastructure project, the project loan bank is not clear about the negotiation project in order to proceed smoothly. In the case of an investor's strong position, it is possible to adopt a strong position strategy or a strong position strategy. We assume that the probability that the project lending bank adopts a strong position to transfer risk is \( p_1 \), the probability of not adopting a strong position transfer risk is \( p_2 \), and \( p_1 + p_2 = 1 \).

3.1. Model establishment

In the case of incomplete information, the project loan bank does not understand the strength and weakness of the actual investor in the negotiation. The project investors do not know whether the project loan bank will adopt a strong position strategy, and the project investors are negotiating. Only subjective probability distribution can be used to predict how likely a project loan bank will take a strong position to transfer risk. Therefore, each round of the bargaining game should be divided into two situations: the project loan bank adopts or does not adopt a strong position strategy. Based on the above analysis, a bargaining game model can be constructed:

In the first round, the project loan bank first proposed the risk of taking the proportion of \( k_1 \) by itself, and the project investor assumed the risk of \( 1-k_1 \). At the same time, the project loan bank used the strong position to force the project investors to accept the transfer by themselves. The additional risk of the share of \( \mu_1 \), the risk of the project loan bank \( B_1' \) and the actual project investor \( I_1' \) is:

\[
B_1' = p_1 (k_1 - \mu_1) \\
I_1' = p_1 (1 - k_1 + \mu_1)
\] (1)

When the project loan bank does not take a strong position to transfer risks to the project investors, the risk of the project loan bank \( B_1'' \) and the project investor \( I_1'' \) is:

\[
B_1'' = p_2 k_1 \\
I_1'' = p_2 (1 - k_1)
\] (2)

Therefore, after the end of the first round of the game, the expected risks assumed by the project loan bank \( B_1 \) and the project investor \( I_1 \) are:

\[
B_1 = B_1' + B_1'' = p_1 (k_1 - \mu_1) + p_2 k_1 \\
I_1 = I_1' + I_1'' = p_1 (1 - k_1 + \mu_1) + p_2 (1 - k_1)
\] (5)

\[
B_1 indicates the risk assumed by the project loan bank in the first round, and \( I_1 \) indicates the risk that the project investor needs to bear in the first round. If the project investor accepts the risk sharing ratio proposed by the project loan bank in the first round of the game, the negotiation is reached and the game is over; if the project investor rejects, the game enters the second round.

In the second round, the project investor proposed the risk that the proportion of the loan was \( 1 - k_2 \), and the project loan bank assumed the risk of \( k_2 \). Because the negotiation will have the cost of negotiation, the more rounds of negotiation between the two sides, the greater the cost of negotiation. At the same time, the project lending bank takes the risk of a strong position transfer ratio of \( \mu_2 \) to the project investor with probability \( p_1 \), then the risk of the project loan bank \( B_2 \) and the project investor \( I_2 \) is:
\[ B_2' = p_1 \Theta_1 (k_2 - \mu_2) \]  
\[ I_2' = p_2 \Theta_2 (1 - k_2 + \mu_2) \]

When the project loan bank does not take a strong position to transfer risks to the project investors, the risk of the project loan bank \( B_1' \) and the project investor \( I_1' \) at this time is:

\[ B_2 = p_2 \Theta_1 k_2 \]  
\[ I_2 = p_2 \Theta_2 (1 + k_2) \]

Therefore, in the second round, the expected value of the risk borne by the project loan bank \( B_2 \) and the project investor \( I_2 \) is:

\[ B_2 = B_2' + B_2 = p_1 \Theta_1 (k_2 - \mu_2) + p_2 \Theta_1 k_2 \]  
\[ I_2 = I_2' + I_2 = p_1 \Theta_2 (1 - k_2 + \mu_2) + p_2 \Theta_2 (1 - k_2) \]

If the project loan bank in the second round rejects the respective risk sharing ratio proposed by the project investors, the game will be dragged into the third round.

The third round: the project loan bank again proposes the risk sharing ratio, which is assumed by the loan bank to take the risk of \( k_3 \), and the project loan bank takes the risk of strong position transfer ratio \( \mu_3 \) to the project investor with probability \( p_1 \), project loan bank The risks that \( B_3 \) and project investor \( I_3 \) need to bear are:

\[ B_3 = p_1 \Theta_1^2 (k_3 - \mu_3) \]  
\[ I_3 = p_1 \Theta_2^2 (1 - k_3) \]

When the project loan bank does not take a strong position to transfer risk to the project investors, the risk of the project loan bank \( I_3' \) and the project investor \( I_3'' \) is:

\[ B_3' = p_2 \Theta_1^2 k_3 \]  
\[ I_3' = p_2 \Theta_2^2 (1 - k_3) \]

Therefore, after the end of the third round of the game, the expected risks borne by the project investor \( I_3 \) and the project loan bank \( B_3 \) are:

\[ B_3 = B_3' + B_3 = p_1 \Theta_1^2 (k_3 - \mu_3) + p_2 \Theta_1^2 k_3 \]  
\[ I_3 = I_3' + I_3 = p_1 \Theta_2^2 (1 - k_2 + \mu_2) + p_2 \Theta_2^2 (1 - k_3) \]

The game is so cyclical that when the lending bank and the investor reach a consensus on the risk-sharing ratio, the game ends.
4. Model solution
The infinite round bargaining game model of risk sharing between project loan banks and actual investors in project financing under the condition of incomplete information is established. In the limited bargaining round, the last round can be used as a counter-pushing base to reverse the induction, so the third round of cooperation is chosen as the counter-pushing point of the infinite round of bargaining. For an infinite round game, no matter whether the third or the first cooperation is the starting node, the calculated minimum share of the bargaining is the same, so there are:

\[ k_3 = \frac{\Theta_2 - 1 + p_1 (\Theta_1 \Theta_2 \mu_3 - \mu_1)}{(\Theta_1 \Theta_2 - 1)} \]  

(19)

\[ 1 - k_3 = \frac{\Theta_2 (\Theta_1 - 1) - p_1 (\Theta_1 \Theta_2 \mu_3 - \mu_1)}{(\Theta_1 \Theta_2 - 1)} \]  

(20)

If the risk \( \mu_1 \) of the loan bank transferred to the project investor per round is assumed to be a constant \( \mu \), then in the infinite bargaining game model, the risk ratios assumed by the project lending bank and the project investor are:

\[ K = \frac{\Theta_2 - 1}{\Theta_1 \Theta_2 - 1} + p_1 \mu \]  

(21)

\[ 1 - K = \frac{\Theta_1 \Theta_2 - \Theta_2}{\Theta_1 \Theta_2 - 1} - p_1 \mu \]  

(22)

It can be seen from formula (22) that in the financing of power infrastructure projects, the risk assumed by the project loan bank can be divided into three parts, and \( K \) is the proportion of risk assumed by the name, \( (\Theta_2 - 1) / (\Theta_1 \Theta_2 - 1) \) for the actual proportion of risk, \( p_1 \mu \) is the risk ratio transferred by the project loan bank to the project investor.

When \( p_1 = 1 \), the project loan bank has the largest share of risk transfer. It indicates that the project loan bank will use its strong position to transfer a certain proportion of additional risks to the project investors; when \( p_1 = 0 \), the project loan bank has no strong position. It indicates that the project loan bank will not use its strong position to transfer a certain proportion of additional risks to the project investors; when \( 0 < p_1 < 1 \), it indicates that the project loan bank cannot fully utilize its strong position to transfer to the project investors a certain proportion. Additional risk.

In the actual power infrastructure project financing, we can determine the negotiation loss silver, strong transfer probability and strong transfer ratio in the game model for various types of identified risks, and calculate the risks between the project loan bank and the project investor according to the model. The share of the share.

5. Conclusion
With the development of power infrastructure projects, the application of project financing will be more and more. Due to the lack of recourse or limited recourse of project financing, the complexity of risk management is much greater than other traditional forms of financing. Therefore, risk identification and analysis of project financing is conducive to coordinating the interests of all parties, and also contributes to the maximum economic benefits of this project. On the basis of risk analysis, the risk sharing mechanism for project actual investors and project loan banks is designed to determine the risk sharing ratio of the two parties in the financing of power infrastructure projects is also the key to project financing success.

In the process of financing the capital infrastructure project, it is necessary to create an environment with perfect conditions and suitable investment and financing for the project, and establish a sound project financing norm; the actual investor and the lending bank establish a good risk identification mechanism and evaluation criteria to clarify the risk allocation and strengthen the risk management.
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