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The application of nested-game theory in the public participation mechanism in the decision-making of large engineering projects

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Abstract:

It is the nested-game theory that provides a new angle for the study on public participation mechanism in the decision-making of large public engineering projects. The public participation is not isolated, but nested in other games. This paper tries to analyze the main bodies' behavior on decision-making during the public participation from the main body of the game and utility, etc. Then it discusses about the effective approach of constructing multi-interests balanced mechanism under the new nested relationship of decision-making on large public engineering projects.

Key words: nested-game, large public engineering projects, public participation, decision-making.

Game theory is to study the decision-making when decision-making main bodies' behavior have direct influence on each other, and also to study the balance of decision-making, which are all based on rational assumptions. In many games, the participants seem to act irrationally, but if treating the game as a part of a larger game you can see their behaviors are rational. Such games are nested in a larger game. In this case, the optimal reaction of the big game might not be the best response to a small independent game, that is to say the small game may be used as a sub-game nested in the sequential game.

THE CURRENT SITUATION OF GOVERNMENT UNI-INTEREST MECHANISM IN THE DECISION-MAKING ON LARGE PUBLIC ENGINEERING PROJECTS

Major public construction project generally refers to the office buildings, tourism, construction, science, education building, communications, construction and transportation construction whose construction area is of 20000 m² or larger than it. The so-called "government monad domination decision-making mechanism" refers to following the model that contains decision-making, planning, preparation, management and implementation of major public construction project under the government's overall lead and control. The government and the public showing asymmetric, non-equilibrium state, the government's absolute strength makes the public's participation too weak. Under the influence of the long-planned economic system, China's major public engineering projects decision-making mechanism divides the work from top to bottom hierarchically and clearly. It has gradually formed the city planning construction administration system from nation to provinces, autonomous regions, municipalities and counties. This paper simplifies the participants of major public engineering projects decision-making game to the central government, the local government and the public.

As the maker of game rules, the central government had a significant impact on game balance. Since it is a familiar system in major public engineering projects, Unitarianism differs from the market economy in both the supply and production relationship: On the supply, consumers are not a few independent individuals or collective, but may be all over a city, region or even the whole nation; on the production, it depends on specialized production institutions of internal organizations, such

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as various large economic and technological state-owned construction enterprises. In addition, the large-scale public engineering projects are usually heavily invested with a long construction period, and the central government allocates special funds for project construction which will greatly boost the local economy and employment rate. Therefore, there’s no doubt that local governments are greatly attracted who consider GDP as an important achievement indicator. Since the power and resource allocation between all levels of governments are top-down constrained, the career prospects of local officials have to rely on the central government, and the central government's recognition is the only path to their job promotion. Unitarianism’s incentives are accompanied with complex negative effects, which will influence the decision-making of major public engineering projects.

As the game participants in the decision-making game of major public engineering projects, the utility function of the central government, local governments and the public are not only directly bound by the of the game itself, but also by the temptation of grade power and the constraint of pressure. Therefore, they have opportunities for rent-seeking tendencies. Namely, to central and local governments, major public engineering projects in decision-making game are nested in the power system game. The role of central and local governments in major public engineering projects’ decision-making are politically affected rather than economically.

At the same time, because the public in major public engineering projects’ decision-making system belongs to a vulnerable group, they couldn’t have any substantial impact on the results. This is mainly based on the following reasons: Firstly,

because of the contradictory nature of participant’s motivation, , though the citizens, as one of the members of the public, concern about their own interests, they may willing to enjoy the public engineering projects’ benefits rather than bear the costs of various decision-making. And the second factor is the loose nature of participating organizations. The public participation is individual, spontaneous, casual, loose and so on, which lacks the effective safeguard from some organizations and systems, and does not have the ability to bargain with the government. The passive nature of participation manner is the third factor. In the absence of adequate internal motivation and planning information, the public and the government are not interactively interrelated. The public have often been misled due to the limitations of themselves and their education levels, as well as the information asymmetry. So in most cases the public are just "inquirers" or “decorators” whose opinions have no restraining force. And the fourth factor is the intermittent nature of participation process. The public’s participation is lagged behind which means that they express their views possibility only in "how" rather than "what". There is no opportunity for them to participate in public engineering projects’ whole decision-making process. And the fifth is the low level of participation. Most of the public still stay at the initial stage of announcements and investigation through the process of major public engineering projects’ decision-making.

THE ANALYSIS ON NESTED-GAME MODEL OF DECISION-MAKING ON LARGE PUBLIC ENGINEERING PROJECTS

The major public engineering projects’ decision-making are reflected the pattern of government monoad domination because the superincumbent constraints relationship of each game main body. Fig. 1 uses nested-game model to explain the process.

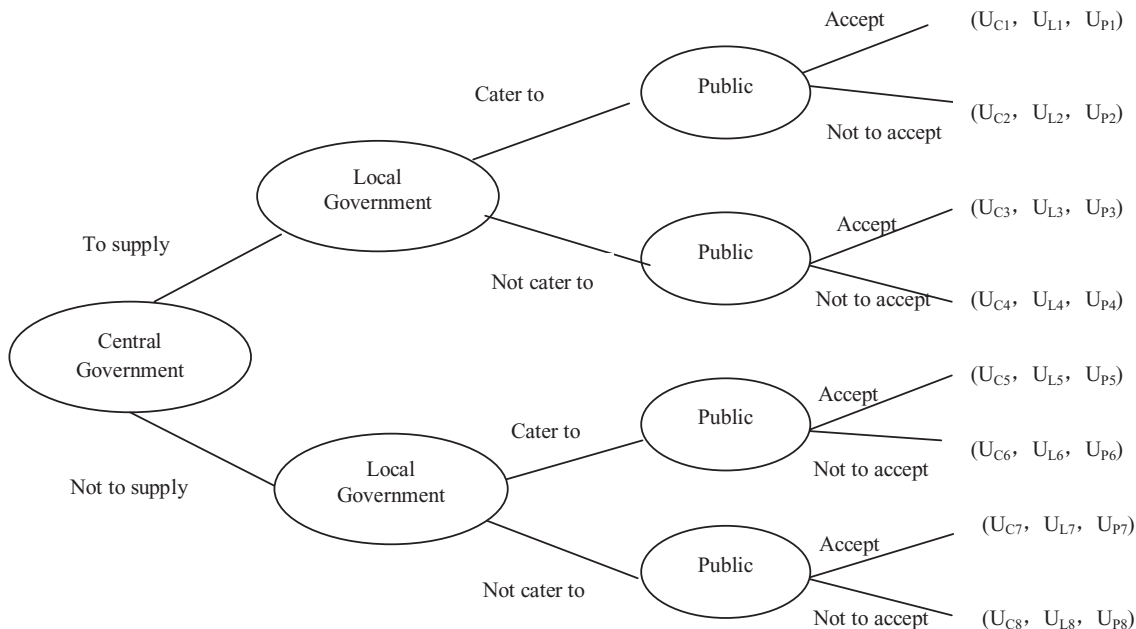


Fig.1 The nested-game model of the decision-making on

In Fig. 1, the participators' utility of major public engineering projects can be expressed the income in game strategy. The central government, local government and the public utility denoted as U_C 、 U_L 、 U_P respectively. the supply and actual demand expressed a distinct imbalance in the public engineering projects due to China has carry out the top-down and government monoad domination mechanism in decision-making and supply for a long time. The public are usually the passive recipients of public engineering projects, so their strategy has little effect on equilibrium outcome of the game. In such a situation, this paper will focus on the local government's strategic choices and analysis the utility function of local government in order to achieve a balanced path.

The utility function of central government, local government and the public denoted as $U_C=U_C(a_{ci}, a_{li}, a_{pi})$, $U_L=U_L(a_{ci}, a_{li}, a_{pi}, E_{lc})$, $U_P=U_P(a_{ci}, a_{li}, a_{pi}, E_{pl})$ respectively. In which a_{ci} 、 a_{li} 、 a_{pi} denote the central government, local government and public's decision-making vector($i=1, 2, \dots, n$) respectively. E_{lc} indicates the local government's decision-making nested in the central government's decision-making, or a recognized level of local government's decision-making by the central government, that is, the consistency of local and central government; and E_{pl} indicates the public's participation nested in local government's decision-making. Local government utility function under the nested-game shows that utility do not only by the impact of their actions, but also from the central government's desire. Similarly, the public participation in decision-making of major public engineering projects also be affected by local governments game. By study the utility function E_{lc} of local government as a case.

large public engineering projects

$$E_{lc} = E_{lc} \left(\sum_{i=1}^n (a_{li} - a_{ci})^2 \right)^{1/2} \quad (1)$$

It substitute the utility function of local government with (1)

$$\begin{aligned} U_L &= U_L(a_{ci}, a_{li}, a_{pi}, E_{lc}) \\ &= U_L(a_{ci}, a_{li}, a_{pi}, E_{lc} \left(\sum_{i=1}^n (a_{li} - a_{ci})^2 \right)^{1/2}) \end{aligned} \quad (2)$$

If E_{lc} is a continuous function and differentiable, there is

$$\frac{\partial U_L}{\partial E_{lc}} > 0 \quad (3)$$

$$\frac{\partial E_{lc}}{\partial \left(\sum_{i=1}^n (a_{li} - a_{ci})^2 \right)^{1/2}} < 0 \quad (4)$$

(3) means when the local government's desirer accord with the central that the game can increase the effectiveness of local government. (4) means when the local and central government's desirer have larger difference, the central government's recognition of local government will fall. Therefore, based on a rational assumption, the local government exist incentives to cater for central government in major public engineering projects decision-making game. In particular, the local government cater to the central government can obtain other benefits outside the public engineering projects game, such as the promotion of local government officials, this kind of revenue will far exceed the benefits that do not cater to the central government's strategy.

China's major public engineering projects decision-making nested-game is a sequential game, in which the central government first show willingness to invest public construction project, local governments will follow to make a choice, and finally is the public's participation. Thinking in accordance with backward induction, the game's equilibrium path as follows:

① the cost of public participation in project decision-making is high, and the individuals of the public do not have the ability to bargain with the government, therefore, rational public will select "accept" strategy, all of the "not acceptable" in basic sub-game have been removed. ② based on public has made it clearly that select "accept" strategy and "cater to" central government will increase its effectiveness, the local governments will choose "cater to", all sub-game with "do not cater to" strategy have been removed. After two eliminate only two equilibrium outcome, namely, (offer, cater to, receive), and (not offer, cater to, receive), the corresponding utility is (U_{C1}, U_{L1}, U_{P1}) and (U_{C5}, U_{L5}, U_{P5}) respectively. ③ When the central government realized that the local government will choose "cater to" strategy, and the public will choose the "accept" strategy too, the central government only according to their own utility function to determine the choice "offer" or "not offer". If $U_{C1} > U_{C5}$, the central government will select "offer", then (U_{C1}, U_{L1}, U_{P1}) is a perfect Nash equilibrium at this time; if $U_{C1} < U_{C5}$,

the central government will choose "not offer", (U_{C5} , U_{L5} , U_{P5}) for the perfect Nash equilibrium; if $U_{C1} = U_{C5}$, the central government will choose one of a strategy according to their own arrangements, and this was a mixed strategy Nash equilibrium.

From above it can be seen that China's major public engineering projects' decision-making had long been under government monoad domination mechanism, from the central government to local governments, the government will have a clearly unanimity from top to bottom, but the public as the basic level and have the strongest demand, lack of the decision-making powers and abilities for public engineering projects. Government monoad domination mechanism neglect of the differences between public preferences and the affluence demands in market conditions, the government's excessive concentration of decision-making power also contrary to the government's objective, such as democratization, transparency and efficiency, resulting decision-making mistakes in major public engineering projects frequently at last.

CONSTRUCT MULTI-INTERESTS BALANCED MECHANISM UNDER THE NEW NESTED RELATIONSHIP OF DECISION-MAKING ON LARGE PUBLIC ENGINEERING PROJECTS

According to the contradictions which caused by government monoad domination decision-making mechanism, many scholars put forward the multi-dominant theory corresponding to monoad domination theory: "multiple" means that a number of decision-making interact independently, there is no one has "ultimate authority" in the exercise of monopoly power, decision-making power in a highly decentralized state. Multi-dominant theory is based on the following assumptions:

(1) the public of each urban community have different preferences for the public projects supply, with the same preferences people tend to live together;

(2) the public in different cities, communities can compare and evaluate the different units in their performance on the provision of public services, the public can choose their own recognized services, express their preferences and concerns effectively.

(3) the local governments in a competitive market environment will have greater motivation to actively provide the public with high-quality public engineering projects services, and carry out effective team production and collaborative production, in order to form the public good reputation and improve their own performance.

(4) in public engineering projects participation decision-making, the public actively participate in it, and to express their real needs and preferences in a legal effective way.

The significance of multi-dominant theory is advocate the public form a new collective consumption units based on the community level, thereby encouraging the public to discuss face to face, so that the public have the opportunity to at least reach a consensus at the community level, and thus began his public engineering projects' participation decision-making action. The public will no longer as before, waiting passively for the decision-making of local government, but participate in public engineering projects decision-making process independently and actively. This is the community self-governance vision, it provides an instructive institution framework: a moderate scale community-based public to replace a single large-scale municipal government administrative departments, and become the original need reflector and the final decision makers of public engineering projects. In this new management framework of overlapping management and mutual cooperation, achieve the demand reflected, planning, decision-making supplies from the past single top-down delivery into a combination of bottom-up and top-down supply modes.

According to the multi-dominant theory and the community self-governance theory, Chinese major public engineering projects' decision-making game main bodies include communities, local governments and the central government. In the changed game structure, community representatives will be elected from the public within the community scale and accept the direct supervision of the public. Therefore, the community representatives from the major public engineering projects' decision-making game is nested in a wider range of local and central government game, and in turn, be bound for the desires of the community public. At the same time, local governments' performance have also been restrict by each community public's satisfaction. Utility function of local government will be changed from the old nested $U_L = U_L(a_{ci}, a_{li}, a_{pi}, E_{lc})$ into a new nest $U_L = U_L(a_{ci}, a_{li}, a_{pi}, E_{lp})$, and $\frac{\partial U_L}{\partial a_{pi}} > 0$, it means the local government's strategy consistent with the desires of the public can increase utility. Similarly, the central government's utility function $U_C = U_C(a_{ci}, a_{li}, a_{pi}, E_{cp})$, and $\frac{\partial U_C}{\partial a_{pi}} > 0$, it means the central government on major public engineering projects' decision-making game nested in great game of various communities public. Game result, local governments and the central government will carry through the major public engineering projects' supply decision-making from the communities public' real need and preference.

In a community-based multi-dominant system, the public express their demands clearly for public engineering projects, and the bottom-up decision-making mechanism can fully reflect the needs of the community public, which will form new multi-dominant game structure of major public engineering projects conducive. On the other hand, it can inspire the enthusiasm of communities to participate in decision-making. So they will work with local governments, the central government to establish a division and coordination multi-dominant mechanism to improve the quality and efficiency of decision-making, and reduce project decision-making mistakes.

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