The Bargain Game Analysis on Policy-Processing of Grid Construction

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***Abstract*—This paper simulates the game in the policy-processing of grid construction based on the Rubinstein game ideology of bargaining, and constructs the Principal-Agent model given the incomplete information for grid company and local government. This paper also discusses the game model for the bargaining between local government and residents and makes an analysis of the mutual action among the three interest groups: grid company, local government and local residents. Probe is made into the achievement of balance in the allocation of benefit for all interest groups under the current policy. The last discussion aims to construct a harmonious external environment for grid construction.**

***Index Terms*—Game analysis, grid construction, interest group, policy-processing, bargaining, principal-agent**

I. Introduction

The policy-processing of grid construction refers to the attainment of agreement between the planner of grid construction and interest groups of external environment. This agreement will guarantee the smooth progress of grid construction. These external environmental factors include: compensation for expropriating civil lands, house relocation and resettlement, compensation for removing attachment on the ground and possible hazard of unearthing underground tubes, compensation for both temporary and restrictive expropriation. The policy-processing of grid construction involves highly numerous and complicated group interest, for the complexity and multi-tier of motive in the behavior of every interest group [1]. To make it possible, we make an economic assumption of all interest groups concerned with the complex external environment in the construction of grid, by setting the policy-processing of grid construction as the game between the land expropriation and its compensation by the grid company, local government and local residents.

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II. On Describing the Problem

As a project of public interest and exhibition of land transfer and governmental imperative force, the policy-processing in grid construction is generally commissioned to local government to negotiate with local residents in terms of compensation for land use. It is the target of the grid company to fulfill its social responsibility and lower construction cost, on condition that the construction project is not affected. The local government aims to coordinate economic development of the local life with its social equivalent, improve the related infrastructure and performance of government officials. Local residents call for a high standard of compensation for grid-construction land expropriation and environmental pursuit [2]. Failure to strike a balance between any two of the three parties will lead to difference in behavior.

Following is the common process for the grid company and the local government to bargain about the compensation standard for land expropriation: first, the grid project engineer will go to the targeted place to make a revenue-collection of the local product price, salary standard of general workers and related fee, and put forward a compensation standard and a scheme of allocating the compensation package. After accumulation, comparison and certain procedures, some resources will be included in the budget estimation of grid construction in the form of ration. After the proposing of grid company, local government will make a balance the price standard for road-management project and industrial garden construction, and publish corresponding standards and methods in the unit of executive counties. Owing to the issue of time-efficiency, there is always some discrepancy between the budget estimation of infrastructure on the part of the grid company and compensation standards on the part of the local government. These two parties will sign an agreement in cases of interest, or reject in cases of sacrificing interest, in the case of which one party will find it very difficult to agree with the project proposed by another party, and will thus propose its demands and feasible solutions, and the other

party will decided to either accept or refuse according to the principle of profit maximization. This round won't end until the satisfaction of both parties. In the round above, the game will naturally come to an end upon the acceptance of project by any party [3]. If the two parties can't reach an agreement within the initial time, another round of negotiation will be necessary, so will the time and energy. Owing to the procrastination of negotiation and consumption of energy, interest of both parties will be consequently discounted, which is measured by $\delta(0<\delta<1)$ called the coefficient of waste, the longer the time of negotiation, the bigger δ.

Similarly, the negotiation of compensation for land expropriation between the local government and local residents are also a game of bargaining, which, however, will come to a conclusion upon the 3rd proposition [4] of the local government. For the part of the local government, each game means a reduction in the gross earnings by a certain proportion. The longer the time of negotiating about compensation for land expropriation, the less benefit for the local government, in which case there may be a delay in the completion of related missions concerning land expropriation, failure to carry out the grid construction project, obstruction to the local economy owing to electrical shortage, the invalidation of the commission between the grid company and the local government, and escalation of conflict [5-8]. To the local residents, the main loss lies in the capital consumed in negotiation and interest loss brought by late arrival of capital (In fact, the local residents worry about economic compensation, social security, obtain employment etc [9]. The paper makes an economic assumption.).

III. Principal-agent Mode between Grid Company and Local Government

Accordingly, grid company always entrust local government to deal with the political problem during which the commission and agent relation between grid company and local government come into being.

A. Explanation of Symbol

ν —the effort degree made by local government in continuous area.

ϕ —opportunity cost of local government, that is the benefit of refusing commission.

$C(\nu)$ —negative avail brought by the effort degree made by the local government ν (cost by hard working).

$R(\nu)$ —avail purchased by the grid company when the local government choose proper ν.

$\omega(R)$ —return to local government based on the avail purchased by grid company $R(\nu)$.

B. Mode of Assumption

Assumption 1: Effort made by local government is uncertain and unsupervised. Grid company chooses return function based on the avail purchased. Local government chooses proper effort degree during the continuous area.

Assumption 2: Grid company and local government belongs to neutral risk.

Assumption 3: $C(\nu)$ turns on a convex function with the continuous increase of ν.

Assumption 4: $R(\nu)$ is a random function of ν which means that the avail purchased by grid company lies not only on effort degree ν but also on random factor θ (the average value of θ is 0).

Assumption 5: $R(\nu)$ turns on a convex with the continuous increase of ν.

Assumption 6: The benefit function of grid company is $R-\omega=R(\nu)-\omega[R(\nu)]$, the benefit function of local government is $\omega-C=\omega[R(\nu)]-C(\nu)$.

C. Mode Description

"1" represents grid company. "2" represents local government. "0" represents "random". The process appears in figure 1.

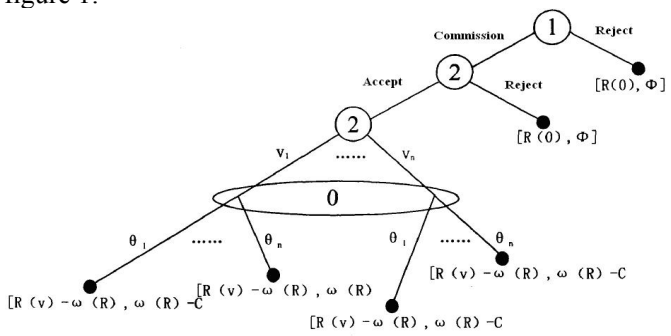

Fig. 1. Bargaining tree of Principal-Agent model

Local government accepts the individual rationality $\omega[R(\nu)]-C(\nu)\geq\phi$ of commission.

Under this premise, grid company would like to pay as little as possible, so the factual individual rationality of local government is $\omega[R(\nu)]=C(\nu)+\phi$. In this way, the benefit function of grid company is $R(\nu)-\omega[R(\nu)]=R(\nu)-C(\nu)-\phi$.

After satisfying the individual rationality, in order to make the benefit of local government match that of grid company which means that local government can get the most benefit, it also must satisfy the incentive compatibility $\omega[R(\nu^*)]-C(\nu^*)\geq\omega[R(\nu)]-C(\nu)$, of local

government. v^* represents the effort degree v which satisfies the incentive compatibility [10].

From the above description, we can conclude a general Principal-Agent mode between grid company and local government:

$$\max_{v} R(v)-C(v)-\varphi \quad s.t.\begin{cases} IR & \omega[R(v)]-C(v)\geq\varphi \\ IC & \omega[R(v^*)]-C(v^*)\geq\omega[R(v)]-C(v) \end{cases} \tag{1}$$

IV. Three Rounds of Bargaining between Local Government and Residents under Incomplete Information Condition

A. Basic Assumption

Assumption 1: The policy-processing result k which grid company entrust local government to compensate local residents regards as internal message by local government. Local residents only know that K is uniformly distributed within the interval $[s,1]$.

Assumption 2: Taking the negotiating fee and loss among the project into account, the "wastage coefficient" (δ) of local government must satisfy $0<\delta<1$. The δ can be neglected because the cost of local residents is little.

Assumption 3: The bargaining round between local government and residents could not exceed three times. Local government makes an offer in the first round and the offer s in the third round is mandatory.

Assumption 4: The two parts are rational. Part 1 represents local government. Part 2 represents local residents.

Assumption 5: Any part in this round would like to accept the offer if it could be no less than the benefit he wants in the next round.

B. Mode Description

The process of this three-round bargaining under incomplete information condition can be described as follows:

Firs round: Local government makes an offer s_1. If local residents accept this offer, respectively, the two parts get $k-s_1$ and s_1. If not, it goes into the next round;

Second round: Local residents ask for s_2. If local government accepts, the two parts respectively get $\delta(k-s_2)$ and s_2. If not, it goes into the next round;

Third round: Local government makes an offer s. Now local residents must accept this offer, and the two parts respectively get $\delta^2(k-s)$ and s.

C. Mode Explanation

Local government makes an offer s_1 in the first round which means that k is uniformly distributed within the interval $[s_1,1]$. The s_2 which local residents made in the second round is to satisfy their maximal benefit. That is:

$$\max_{s_2}[s_2\cdot p_a+s\cdot p_r] \tag{2}$$

p_a represents the probability that local government may accept s_2. p_r represents the probability that local government may reject s_2. For local government, it can only accept s_2 under the condition that the benefit $\delta(k-s_2)$ is no less than the benefit $\delta^2(k-s)$ in the third round. That is $\delta(k-s_2)\geq\delta^2(k-s)$ which results in $k\geq\frac{s_2-\delta s}{1-\delta}$. For this reason, we can get the conclusion as follows:

$$p_a=p\left\{k\geq\frac{s_2-\delta s}{1-\delta}\right\}=\frac{1-\frac{s_2-\delta s}{1-\delta}}{1-s_1}=\frac{1-\delta-s_2+\delta s}{(1-\delta)(1-s_1)} \tag{3}$$

$$p_r=p\left\{k<\frac{s_2-\delta s}{1-\delta}\right\}=\frac{\frac{s_2-\delta s}{1-\delta}-s_1}{1-s_1}=\frac{s_2-\delta s-(1-\delta)s_1}{(1-\delta)(1-s_1)} \tag{4}$$

Put it in formula (2), we get:

$$\max_{s_2}\left[s_2\cdot p_a+s\cdot p_r\right]=\max_{s_2}\left[s_2\cdot\frac{1-\delta-s_2+\delta s}{(1-\delta)(1-s_1)}+s\cdot\frac{s_2-\delta s-(1-\delta)s_1}{(1-\delta)(1-s_1)}\right] \tag{5}$$

$$\text{Then } s_2^*=\frac{1-\delta+\delta s+s}{2} \tag{6}$$

For this reason, the maximal benefit for local residents is

$$s_2^*\cdot\frac{1-\delta-s_2^*+\delta s}{(1-\delta)(1-s_1)}+s\cdot\frac{s_2^*-\delta s-(1-\delta)s_1}{(1-\delta)(1-s_1)} \tag{7}$$

Now we return to the first round. If we want the residents to accept the offer s_1 which local government made to close the negotiation, the benefit local residents purchased must be no less than their maximal expectation. That is

$$s_1=s_2^*\cdot\frac{1-\delta-s_2^*+\delta s}{(1-\delta)(1-s_1)}+s\cdot\frac{s_2^*-\delta s-(1-\delta)s_1}{(1-\delta)(1-s_1)} \tag{8}$$

Then

$$s_1^* = \frac{1+s-\left((1+s)^2-\frac{(1-\delta+\delta s+s)^2-4\delta s^2}{1-\delta}\right)^{1/2}}{2} \quad (9)$$

Consequently, local government gets $k-s_1^*$, and local residents get s_1^*, they are the perfect Bayesian equilibrium of this game.

D. Model Analysis

In the model of bargaining, supposing in the third round, the local government compulsorily offers s as the statutory lower limit of compensation, and ultimate benefits to the local residents wouldn't be less than s, namely:

$$s_1^* = \frac{1+s-\left((1+s)^2-\frac{(1-\delta+\delta s+s)^2-4\delta s^2}{1-\delta}\right)^{1/2}}{2} \geq s \quad (10)$$

Formula (10)'s demonstration (proof by contradiction) is

$$\frac{1+s}{2}-\frac{1}{2}\sqrt{(1+s)^2-\frac{(1-\delta+\delta s+s)^2-4\delta s^2}{1-\delta}} \geq s \quad (11)$$

$$\frac{1-s}{2} \geq \frac{1}{2}\sqrt{(1+s)^2-\frac{(1-\delta+\delta s+s)^2-4\delta s^2}{1-\delta}} (1-s>0) \quad (12)$$

$$(1-s)^2-(1+s)^2 \geq \frac{(1-\delta+\delta s+s)^2-4\delta s^2}{1-\delta} \quad (13)$$

$$(1-\delta)^2 \geq 0 \quad (14)$$

The model indicates: under the condition of incomplete information, if the local residents were given the right of bargaining, they would be compensated no less than the statutory lower limit.

V. Analysis of Three Interest Relationships among Grid Company, Local Government and Local Residents

Considering the three parts combined, under the premise of the local residents being compensated no less than the statutory lower limit of compensation, the grid company would think about how to set up an incentive mechanism that local government can accept. The mechanism can lower its cost to the minimum in policy-processing.

The final benefit to the local government in the bargaining model is:

$k-\frac{1+s}{2}+\frac{1}{2}\sqrt{(1+s)^2-\frac{(1-\delta+\delta s+s)^2-4\delta s^2}{1-\delta}}$, which can be regarded as a utility level of the grid company, namely $R(v)=k-\frac{1+s}{2}+\frac{v}{2}$, k and s are prescribed value,

$v=\sqrt{(1+s)^2-\frac{(1-\delta+\delta s+s)^2-4\delta s^2}{1-\delta}}$ is the local government's effort level. Due to the utility of the grid company not only depending on the local government's hard-working, it also concerns external random factors and so on, therefore, R and v are the random functions, that is

$R(v)=k-\frac{1+s}{2}+\frac{v}{2}+\theta$, θ is a random disturbance term whose average is zero. Also, to suppose that the negative utility function of the local government is $C(v)=\left(k-\frac{1+s}{2}+\frac{v}{2}\right)\cdot v$, while its opportunity cost ϕ of accepting commission is known.

The grid company can't get hold of the real effort level of the local government, so only to pay based on the obtained utility level. Suppose the formula used in the return by the gird company is:

$\omega(R)=A+B[R(v)]=A+B\left(k-\frac{1+s}{2}+\frac{v}{2}+\theta\right)$, A and B are all constants [10]. Such return formula reveals that the return for local government consists of the fixed remuneration and commission. So, the revenue function of the grid company is

$R(v)-\omega(R)=(1-B)\left(k-\frac{1+s}{2}+\frac{v}{2}+\theta\right)-A$, because θ is a random value whose average is zero, the expected profit of the grid company is $(1-B)\left(k-\frac{1+s}{2}+\frac{v}{2}\right)-A$.

The revenue function of the local government is

$$\omega(R)-C(v) = A+B\left(k-\frac{1+s}{2}+\frac{1}{2}v+\theta\right)-\left(k-\frac{1+s}{2}+\frac{v}{2}\right)\cdot v$$

The expected profit is

$$A+(B-v)\left(k-\frac{1+s}{2}+\frac{1}{2}v\right)$$

Now the key point is to confirm the value of A and B to make this return mechanism to be an effective incentive mechanism.

Put the above data into formula (1), then get out the principal-agent model between the gird company and local government, namely:

$$\max_{A,B}(1-B)(k-\frac{1+s}{2}+\frac{1}{2}v)-A$$

$$s.t.\begin{cases} A+(B-v)\left(k-\frac{1+s}{2}+\frac{1}{2}v\right)\geq\phi \\ A+(B-v)\left(k-\frac{1+s}{2}+\frac{1}{2}v\right)\geq A+(B-v')\left(k-\frac{1+s}{2}+\frac{1}{2}v'\right) \end{cases} \quad (15)$$

Meanwhile： v' is any other effort level adopted by the local government except v .

The solution to the model is

$B=1, A=-\frac{1}{2}\left(k-\frac{s}{2}\right)^2+\phi$, That is to say, the best incentive return formula of the grid company is:

$\omega(R)=A+BR=\left[-\frac{1}{2}\left(k-\frac{1}{2}s\right)^2+\phi\right]+R$, which means that， 100% effectiveness of land compensation becomes to be the commission of the local government, the grid company doesn't have to pay the fixed remuneration, however, could get an additional utility of $\frac{1}{2}\left(k-\frac{1}{2}s\right)^2-\phi$. Therefore, the contracted responsibility system is the best incentive mechanism for the grid company.

VI. Conclusions and Suggestion for Policy

This paper builds the Principal-agent model of grid company and local government, and the incomplete informational bargain mode of local government and local residents. This paper also makes a combination of the fore-mentioned, and interaction & balance for grid company, local government and local residents. Three conclusions are made as follows:

1) Government should take a lead in the policy-processing of grid construction. The role government decides to play and interest relationship has a direct influence on the legality of grid construction and the reasonable utilization of resources in construction. The grid company, as an executive department in the construction of grid, should lay great emphasis on and utilize the geographical advantages and enhance effective communication and coordination with local government. Local government should be encouraged to utilize power of all strata to guarantee the smooth policy-processing of grid construction.
2) Make sure that local groups and residents are informed of and involved in land expropriation. This will come before the reasonable compensation for local residents. In fact, there are some organizations or people who, in negligence of written texts concerning compensation for grid construction, deducts construction fee at every approachable level and leads to the civil interruption of grid construction owing to inadequate compensation. It's advisable that the grid company could, in the preliminary phase of grid construction, employ an alternative channel to make public the compensation standard for land expropriation, so as to reduce unnecessary impact on the grid construction due to incomplete information.
3) The optimal mechanism of impetus in the policy-processing of grid construction is the contracted responsibility system by the local government. The construction and perfection of interest balance in land expropriation will contribute to the macro-target of the grid company.

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