MODEL FOR GOVERNMENT RESCUE POLICIES IN PUBLIC-PRIVATE PARTNERSHIP PROJECTS

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ABSTRACT : Today, government is no longer considered the sole provider of public works or services. Public-Private Partnership (PPP) has been recognized as an important approach to solving problems for governments in providing public works and services. However, the joint ownership of public works/services complicates the administration of PPP projects. Particularly, the fact that government may rescue a distressed project and renegotiate with the developer causes serious problems in project procurement and management. This paper aims to study when and how government will rescue a distressed project and what impacts government's rescue behavior has on project procurement and contract management. A game-theory based model for government rescue will be developed. This pilot study, the author hopes, may provide theoretic foundations to practitioners/policy makers for prescribing creative PPP procurement and management policies and for examining the effectiveness of PPP policies.

Key words : Project procurement, Contracting, Public-private partnership, Government policy, BOT, PFI

1. INTRODUCTION

Privatization has been recognized as an important approach to solving the problem for governments in providing public works [1, 2]. A more generic term for the privatization of public works is Public-Private Partnership (*PPP*), which refers to the long-term private participation in providing public works or services.

Typically, the *PPP* contract is considered the result of first negotiation during project procurement. The negotiation process at this stage was discussed by Tiong and Alum [3]. Renegotiation refers to the second negotiation after the contract being signed, usually when conditions change and all signing parties agree to modify or redraft a contract. In *PPP*, renegotiation may happen when project cost, market demand, or other market conditions change unfavorably and significantly, in comparison to original figures in the bidding proposal, so that government is forced to either terminate the *PPP* contract or renegotiate a rescuing subsidy. If government always agrees to renegotiate with developers and rescue a project, renegotiation will be expected by developers and such expectation can cause problems in project procurement and contract management. The first problem in *PPP* is the lack of optimal incentives, whereas optimal incentives are crucial to project success, given information asymmetry. The second problem is the opportunistic bidding behavior. In *PPP*, opportunistic bidding means that the bidders, in their proposals, intentionally underestimate possible risks involved or overestimate the project profitability in order to outperform other bidders.

This paper presents a Game theoretic model to analyze government's procurement and management policies from the perspective of government rescue behavior.

2. RESEARCH METHODOLOGY

The methodology adopted for theoretical investigation and analysis is game theory. In *PPP* projects, conflicts among project developer and government are very common, particularly in an adverse situation, and therefore, game theory is a natural tool for analyzing the problem. Game theory has also been adopted by Ho and Liu [4] to analyze the behavioral dynamics of construction claims.

2.1 Types of Games

There are two basic types of games: static games and dynamic games, in terms of the timing of decision making. In a static game, the players act simultaneously. In a dynamic game, the players act sequentially. Due to the nature of government rescue, the dynamic game will be used for modeling and analyzing the renegotiation and its associated problems. More detailed introduction can be found in Ho [5].

2.2 Game Solution: Nash Equilibrium

As to answer what each player will play/behave in this game, we shall introduce one of the most important concepts: "*Nash equilibrium*." In a Nash equilibrium, each player's strategy should be the best response to the other player's strategy, and no player wants to deviate from the equilibrium solution. Thus, the equilibrium or solution is "strategically stable" or "selfenforcing" [6]. A dynamic game can be solved by maximizing each player's payoff *backward recursively* along the game tree. We shall apply this technique in solving the government rescue game.

3. GOVERNMENT RESCUE GAME AND EQUILIBRIA: THE MODEL

A *PPP* investment is a risky investment. According to Ho and Liu [7], those risks that concern the project valuation can be categorized as completion risk and operating risk. In some extremely adverse situations, such as drastic cost overrun or economic changes, the investment may become financially unviable or distressed. The fact is that if the developer considers the impact of the completion and operating risk, or called risk impact, the financial viability of an investment will "appear" to be lower than when the risk impacts are understated or not even considered. Thus, if the developer knows for sure in advance that government will rescue a distressed project, then the developer will not have to assume the risk impact, and consequently the investment will seem to be more viable financially in the project proposal.

3.1 Model Setup

The game theoretic framework for analyzing a *PPP* investment shown in Fig. 1 is a dynamic game form. Suppose a *PPP* contract does not specify any government rescue or subsidies in the face of critical adverse events. Suppose that government is not encouraged to rescue a project without compelling and justifiable reasons. Thus, it is reasonable to assume that if government grants a subsidy to a project on the basis of unjustifiable reasons, the loss of public trust or suspicion of corruption will be a possibility.

The dynamic game, as shown in Fig. 1, starts from adverse situations where it is in the developer's (denoted by D) or lending bank's best interests to abandon the project if government (denoted by G) does not rescue the project. Alternatively, the developer can also request government to rescue and subsidize for the amount of \$*U*, even though the contract clause does not indicate any possible future rescue from government, where *U* denotes the maximum possible subsidy, the maximum possible amount that could be claimed for subsidy.

If the developer chooses to abandon a project, the payoff will be $-\delta$, where $\delta \rightarrow 0$. The main reason is that the value of the *equity shares* held by the developer should approach zero right before the abandonment. On the other hand, if a *PPP* project is abandoned, the payoff of government is $-n(B)$, where *B* is government's "budget overspending" when a project is abandoned and retendered, and *n*, a function of *B*, is the *political cost due to the project retendering*. Generally, from either a financial or political perspective, it is costly for government if a *PPP* project is abandoned by the developer. Thus, it is assumed that retendering is desired by government if a project is bankrupted or abandoned by a developer.

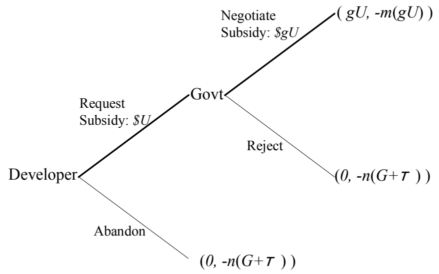

Fig. 1. Negotiation Game's Equilibrium Path

Alternatively, the developer can renegotiate a subsidy in the maximum amount of \$*U* from government as shown in Fig. 1. The subsidy can be in various forms such as debt guarantee or concession period extension. After the developer's request for subsidy, the game proceeds to its subgame, shown in Fig. 1: "negotiate subsidy" or "reject." If the government rejects the developer's request, the developer will abandon the project and the payoff for both parties will be $(0,-n(B))$. If government decides to negotiate a subsidy, expressed by the *rescuing subsidy ratio*, *g*, a ratio between 0 and 1, the payoff of the developer and government will be $(gU, -m(gU))$, respectively, where *m* is the *political cost due to the rescuing subsidy to a private party*. Note that function *m* is different from function *n*, because in the two functions the budget spending goes to different parties.

3.2 "Negotiate and Rescue" or "Abandon:" Nash Equilibria of the Rescue Game

Here we will analyze the conditions for possible Nash equilibria of the game. The three candidates for the Nash equilibria are as follows.

1. Developer will "request subsidy" and government will "negotiate subsidy."

   Here, this equilibrium will be called "rescue" equilibrium. Solving backward from the government's node first, if the payoff from negotiation is greater than that from rejection, i.e.,$-m(gP) \geq -n(B)$, government will "negotiate subsidy" with the developer. Therefore, the condition for negotiation or rescue can be rewritten as:

$$m(gU) \leq n(B) \tag{1}$$

   As shown in Fig. 1, the payoff for the developer and government will be $(gU, -m(gU))$, respectively.

The next step is to solve backward again and obtain the final solution. According to the tree following first node in Fig. 1, the developer will request subsidy if $gU \geq 0$. Since *g* and *U* will not be negative numbers, the condition for the developer to negotiate will always be satisfied. In other words, it is always to the developer's benefit to negotiate subsidy if equation (2) is satisfied. Thus, the negotiation offer can be expressed as:

$$gU \in \{x : x \geq 0, m(x) \leq n(B)\} \quad (2)$$

From equation (2), we know that as long as $n(B)$-$m(gU) \geq 0$, the rescue equilibrium will be the solution of the game, where no one can be better off by deviating from this equilibrium. Note that the condition for this equilibrium needs to be refined due to other concerns.

2. Developer will "request subsidy" and government will "reject."
   If equation (1) is not satisfied, "reject" would be a preferable decision to government. As a result, the payoff matrix for both parties is $(0, -n(B))$. Now turn to the developer's node: if the developer recognizes the existence of the cost incurred in the process of requesting subsidy, and if the developer knows government will "reject" the subsidy request, the developer will choose "abandon," instead of "request subsidy" in the first place, and this is exactly the third possible equilibrium, developer "abandon." Thus, the second equilibrium solution cannot exist.
3. Developer will "abandon."
   Here, we shall term this equilibrium the "no rescue" equilibrium. The condition of this Nash equilibrium would be:

$$m(gU) > n(\mathrm{B}) \quad (3)$$

In other words, for "abandon" to be an equilibrium solution, it must be that it is impossible to achieve the "rescue" solution. Equation (4) can be rewritten as

$$n(B) - m(gU) < 0 \quad (4)$$

To conclude this section, we find equations (1) and (3) for the *PPP* rescue game's "rescue" and "no rescue" equilibria, respectively.

3.3 Modeling of Game Parameters

3.3.1 *Political Cost of Rescuing a Project by Subsidy*

If government negotiates the subsidy with the existing developer and rescues the project, the function of the political cost to government is modeled here as

$$m(gU) = \begin{cases} \beta(gU) & \text{if } gU \leq J \\ \beta(gU) + \rho_s(gU) & \text{if } gU > J \end{cases} \quad (5)$$

where J is the amount of the subsidy that can be justified without the criticism of oversubsidization, $\beta(gU)$ is the political cost of budget overspending, and $\rho_s(gU)$ is the political cost of oversubsidization, where "s" denotes subsidy.

The modeling of the political cost of subsidy in equation (5) is based on the concept that resources are scarce. As a result, the political cost of subsidy should be a strictly increasing function of the amount of subsidy, gU. In equation (5), the political cost is further broken down into two elements, namely, $\beta(gU)$ and $\rho_s(gU)$. $\beta(gU)$, as illustrated in Fig. 2, is an increasing function of gU, representing the political cost caused by budget overspending in subsidy, and is considered the "basic" political cost. In addition to the basic political cost, it is argued that for subsidy exceeding certain justifiable amount, further political cost, $\rho_s(gU)$, would incur so as to reflect a more serious resource misallocation. In the model, J is termed the "justifiable subsidy," which is considered by the public an eligible claim for subsidy. If the subsidy is less than the justifiable claim, government will not be blamed for oversubsidization, and therefore, $\rho_s(gU)$ will be considered zero when $gU \leq J$. However, when the subsidy is greater than J, government will be criticized for oversubsidization, or be accused of or suspected of corruption, and will suffer further political cost, $\rho_s(gU)$, in addition to $\beta(gU)$. Figure 2 shows the function *m(gU)* obtained by combing the two functions.

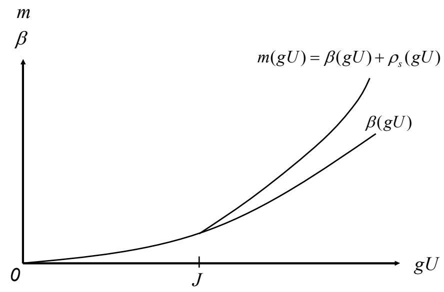

Fig. 2. $m(gU)$, the Political Cost Function of Rescuing a Project

3.3.2 *Political Cost of Retendering a Project*

When a project is financially distressed, it will be considered "sold" to government and retendered to some other private developer given the assumption that the project is still worth completing. Therefore, one may consider the project bankruptcy as government's "regaining" and "retendering" a project, or a costly replacement of the developer. As a result, when a project is bankrupted, the amount of budgeting overspending can be modeled:

$$B = G + \tau \quad (6)$$

where G is the least required subsidy that can persuade the lending bank to support a distressed project, and τ is the developer replacing opportunity cost, which may include the retendering cost and the cost of interruption due to the bankruptcy and retendering process.

Similar to the political cost of rescuing a project, the political cost of project retendering can be modeled by:

$$n(B) = \beta(B) \quad (7)$$

Substitute equation (6) into (7), and then equation (7) can be rewritten as

$$n(G+\tau)=\beta(G+\tau) \quad (8)$$

as shown in Fig. 3.

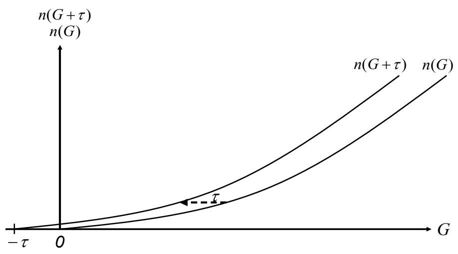

Fig. 3. Function $n(G+\tau)$ when τ is Fixed

3.3.3 *Mathematical Characteristics of the Game Parameters*

Characteristic 1. By the definition of *G*, the subsidy to the project must be $gU \geq G$.

Characteristic 2. Although the developer replacing opportunity cost is always positive and significant, here we shall only make a weaker assumption that τ is non-negative.

Characteristic 3. Since not all losses due to financial viability change can be justified for subsidy during negotiation, the range of *J* can be modeled as $J \in [0,U]$.

3.4 Refined Nash Equilibrium

Previous sections conclude that equations (1) and (4) are the conditions for "rescue" and "no rescue" equilibria, respectively; however, it is also noted that these conditions need to be refined. By Characteristic 1, to rescue a project the subsidy must be at least equal to *G*, i.e., $gU \geq G$. As a result, the condition for rescue equilibrium becomes $m(gU) \leq n(B)$, where $gU \geq G$. Applying equation (6), we then have

$$m(gU) \leq n(G+\tau) \text{ where } gU \geq G \quad (9)$$

Since *m*(*gU*) is an increasing function, *gU* must have an upper limit, below which the inequality in equation (13) is satisfied. Thus, the condition for rescue equilibrium can be reorganized and expressed by the lower and upper limits of the subsidy as shown in equation (10):

$$gU \in \{x : G \leq x \leq m^{-1}[n(G+\tau)]\} \quad (10)$$

where $m^{-1}[n(G+\tau)]$ is the inverse function of *m*. Here equation (10) will be called "Negotiation offer zone." Figure 4 shows the rescue equilibrium condition, equation (9) and the negotiation offer zone, indicated by the grey bar in the *x* axis. Given any *G* in Fig. 4, $n(G+\tau)$ will be determined first, and then $m^{-1}[n(G+\tau)]$ is obtained so that any *gU* between *G* and $m^{-1}[n(G+\tau)]$ will satisfy eqn. (9).

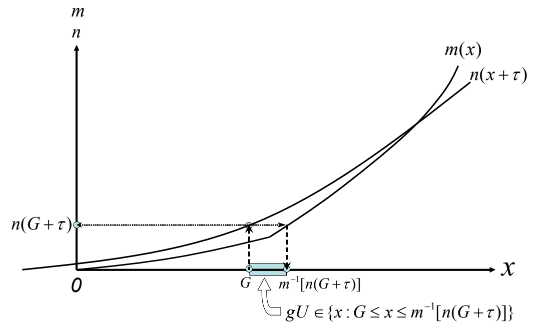

Fig. 4. Negotiation Offer Zone in a Rescue

4. PROPOSITION AND COROLLARY

The following propositions and corollaries can be formally proved. However, due to the length limitation, we shall forgo the formal proof here. Interested readers may contact the author for details.

Proposition 1:

Assume that the rescue negotiation process follows the game tree in Fig. 1. Given *U*, *G*, τ and functions *m* and *n*, if $m(gU) \leq n(G+\tau)$, where $gU \geq G$, government will rescue a distressed *PPP* project with a negotiated subsidy, ranging $gU \in \{x : G \leq x \leq m^{-1}[n(G+\tau)]\}$.

Proposition 2:

If all assumptions in proposition 1 hold, the equilibrium must be to negotiate if $G \leq J$.

Corollary 1:

Suppose all assumptions in proposition 1 hold, the equilibrium must be to rescue if $G \leq J-\tau$ and the negotiation offer zone is $gU \in \{x : G \leq x \leq G+\tau\}$.

Corollary 2:

Suppose all assumptions in proposition 1 hold. When there exists a S_α defined by $S_\alpha = m^{-1}[n(S_\alpha+\tau)]$ and $\forall x \leq S_\alpha : m(x) \leq n(x+\tau)$, the equilibrium must be to rescue if $G \leq S_\alpha$, or no rescue if $G > S_\alpha$.

Corollary 3:

Suppose all assumptions in proposition 1 hold, the equilibrium must be to rescue if it is always true that $J = U$.

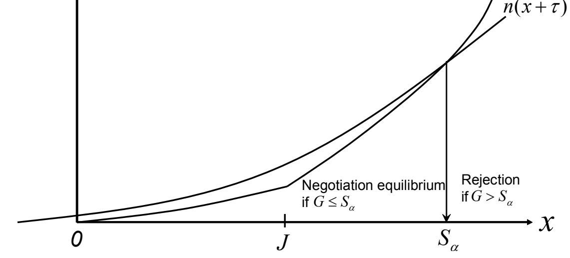

Fig. 5. Illustration of Corollaries 2

5. GOVERNING PRINCIPLES AND POLICY IMPLICATIONS

Suggested governing principles and implied policies for managing *PPP* projects are derived from previous findings.

Governing Principle 1: Be well prepared for renegotiation problems, as it is impossible to rule out the possibility of renegotiation equilibrium.

Since it is always possible that $G \le S_\alpha$ given that *G* is uncertain, it is impossible to rule out the possibility of renegotiation equilibrium. As a result, the government should be well prepared for problems induced by renegotiation. Policy implications from this principle include:

- For the opportunistic bidding problem, government should always have a doubt on the information provided by the developer.

Governing Principle 2: Although renegotiation is always a possible equilibrium, the probability of renegotiation should be minimized and could be reduced by strategies that increase ρ_s *and reduce* τ *and J.* Policy implications from this principle may include the following:

- Specific laws may regulate the renegotiation or negotiated subsidy, and such laws will increase ρ_s when the subsidy is not justifiable.
- A good monitoring or early warning system can also give government enough lead time to prepare for replacing a developer with minimal impacts, and hence, reduce τ .
- To reduce *J*, government should pay attention to the quality of the contract in terms of content and implementation, e.g., the scope, risk allocation, documentation, and contract management.

Governing Principle 3: During the negotiation process, the government should try to settle the negotiation at G, and spend more efforts on knowing G and conveying such information to the project developer, rather than on negotiation skills. Policy implications may include:

- Government could regulate the negotiated subsidy by the laws that explicitly forbid a subsidy being greater than *G*.

Governing Principle 4: Government should make every effort on having more information to determine a fair J which corresponds to the developer's responsibilities specified in the contract, and on allocating risks and responsibilities appropriately.

Holliday et al. [8] argued that because of the scale and complexity of BOT projects, such as the Channel Tunnel, very often they are *developer-led*, and it is extremely difficult to identify a clear client-contractor relationship at the heart of the project. As a result, there will be information asymmetry problem in such developer-led *PPP* projects, and government should do everything possible to minimize the information asymmetry on *J*. Another issue is that *J* is fair only when the allocation of risks and responsibilities is appropriate. As Ho and Liu [4] proved, harsh contract will only encourage opportunistic behaviors. Policy implications may include:

- Government can separate the developer from the builder/contractor in a *PPP* project in order to have a clearer client-contractor relationship.
- Government can also assign third party experts to serve on the Board of the project company so that proper monitoring and inside information collection are assured.
- Government can have a procedure in forming a special committee consisting of outside experts to determine a fair *J* for the distressed project.
- Government is suggested to carefully specify when and how government can step in.
  - Government could step in and temporarily take over a project when the project is in trouble according to the monitoring or warning system mentioned above.
  - By temporarily taking over a project, government has obtained more objective information regarding *J* and *G*, and may also reduce τ due to longer lead time to respond and prepare for the coming distress.
- Government should devote more efforts on appropriate risk allocation in the contract, than on harsh contract clauses.

6. CONCLUSIONS

This paper investigates how government and the project developer will behave in various renegotiation situations when a *PPP* project is in distress, and what impacts government rescue has on procurement and management polices. Note that, as in many Economics studies, some simplified assumptions are made in this research so that useful insights can be drawn from real life complex situations. These insights could provide decision makers with useful conceptual and directional principles, despite that the real situation is more complex. In this paper, five governing principles and their policy implications are obtained and discussed. This pilot study, the author hopes, may provide a theoretic foundation and analytic logic, from the renegotiation perspective, for prescribing creative *PPP* administration policies in different countries and for examining the effectiveness of existing *PPP* guidelines and policies.

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