GOVERNMENT POLICY ON PPP FINANCIAL ISSUES: BID COMPENSATION AND FINANCIAL RENEGOTIATION

(Manuscript of a PPP book chapter)

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Abstract

Too often, in *PPPs*, many serious problems occur mainly because of bad administration policies. When we have chances to participate in policy making, we should base our decisions on solid economics ground as well as engineering discipline, instead of intuition based superficial reasoning. In this chapter, we will introduce two theoretical models and their applications in PPP policies concerning two important issues: bid compensation and financial renegotiation. The two financial related issues are closely associated with the success of project procurement and contract administration. A case study of Taiwan High Speed Rail is conducted to illustrate the applicability of the renegotiation model and to discuss the lessons learned from the perspective of renegotiation model introduced. The two game-theoretical models are expected to provide policy makers or government a more rigorous framework for crafting their administration policies and PPP guidelines.

1. Introduction

Private participation has been recognized as an important approach for governments in providing public works and services (Walker and Smith, 1995; Henk, 1998). Whereas BOT, PFI, and DBFO etc. are popular variations and terms of such private participation framework, Public-Private Partnerships (*PPP*s) can be considered the most general term for the schemes of this kind. According to a report by US Federal Highway Administration (2005), from 1985 to 2004, there were about 1,120 major *PPP* projects worldwide funded and completed, and the total dollar amount for these projects were around $450 billions US dollars. For example, in UK, *PPPs* are now a major scheme in supplying the needs of public works. *PPPs* have also become increasingly popular in Asia. For instance, in year 1999, Japan passed the PFI Law in supporting the use of *PPPs*. Other Asian countries that adopted *PPPs* include Hong Kong, Taiwan, Thailand, China, Singapore, Korea, and Philippine. In 2000, Taiwan, the writer's home country, enacted *The Act for Promotion of Private Participation in Infrastructure Projects* and began to aggressively promote the use of *PPPs.* Up to April 2005, there have been about 280 *PPP* projects funded in Taiwan, with US$ 25 billions or so invested by private parties. The Taiwan High Speed Rail, just commenced on January 2007, a US$ 18.4 billions mega project, is the largest *PPP* project in Taiwan and also one of the largest *PPP* projects in the world. The Taipei 101 building, 508 meters in height, currently the tallest high rise building in the world, is also funded under *PPPs*.

Because the *PPPs* involve special relationships between public and private parties as well as complex financing issues, the administration of *PPP* projects has been a challenging task. Too often, in *PPPs*, many serious problems occur mainly because of bad administration policies. In practice, there are various guidelines for managing *PPP* projects in countries such as UK, however, these guidelines cannot be universal to every country in the world and thus need to be modified to fit specific environment of a country according to certain logic. Therefore, when we have chances to participate in policy making, we should base our decisions on solid economics ground as well as engineering discipline, instead of intuition based superficial reasoning. The purpose of this chapter is to introduce two game-theoretical models for *PPP* administration policies on two important issues: bid compensation and financial renegotiation.

Bid compensation, an often seen practice for projects with high bid preparation cost, is the stipend or honorarium paid by the owner to the unsuccessful bidders to compensate the cost of bid preparation. Is bid compensation a problem in *PPPs*? According to the writer's consulting experiences, many project owners, especially government authorities, are very keen to know whether they should offer bid compensation and how much to offer. The writer once received an email from a senior consultant for partnerships British Columbia (Canada) requesting assistance and the research result for the crafting of their bid compensation policy. Yes, bid compensation is a problem in *PPPs*. The smaller problem is that the owners may waste money in bid compensation if the compensation is not effective. The bigger problem is that if bid compensation is not effective and governments are not aware of its ineffectiveness, governments will lose their chances of adopting other approaches to improving bid quality or concept development. In this chapter, we introduce a model by Ho (2005) that studies how bidders react to bid compensation and what the policy implications are.

Financial renegotiation problem plays an even more crucial role in the success of a *PPP* project. Financial renegotiation refers to the rescuing financial subsidy negotiation after the contract being signed, when conditions change unfavorably and significantly. The importance of financial renegotiation policy goes beyond whether governments should renegotiate with private parties. The greater concern is that the fact that government may bail out a distressed project and renegotiate with the developer in *PPPs* has caused serious opportunism problems in project administration. Therefore, what we really concern in *PPPs* is that how to reduce the probability of future renegotiation and the opportunism due to the renegotiation possibility. Here we will discuss a model by Ho (2006a) that investigates how government and project developers will behave in various renegotiation situations when a *PPP* project is in distress, and what impacts government rescue has on procurement and management polices. This model may help to provide theoretic foundations to policy makers for prescribing effective *PPP* procurement and management policies and for examining the quality of *PPP* policies. The model can also offer researchers a framework and a methodology to understand the behavioral dynamics of the parties in *PPPs*.

It is worth noting that compared to survey- or case- based research, the models introduced here have the advantage of considering the contracting and administration problems without the limitation of specific practical or study environments (Ho, 2006b). In other words, environmental differences can be factored into an analytical model with some degree of simplification and the model can become more general. And this is why we think that the two game-theoretical models may provide policy makers or government a more rigorous framework for crafting their administration policies or suggested PPP guidelines suitable for their environments.

This chapter is organized as follows. Section 2 will briefly introduce the methodology behind the two models introduced, game theory. In section 3, we will look at the derivation and results of the model concerning the use of bid compensation in *PPPs*. Section 4 introduces the *PPP* financial renegotiation model and its administration policy implications. A short case study will be given to present the lessons learned from the perspective of the model introduced. Section 5 concludes.

2. Research Methodology: Game Theory

Game theory can be defined as "the study of mathematical models of conflict and cooperation between intelligent rational decision-makers" (Myerson, 1991). Game theory by far is one of the most important analytical tools in studying economic behaviors of individuals, corporations, and societies. Whereas more and more problems are analyzed and understood by applying the game theory, the game theory itself also continues to advance. There is no doubt that the game theory is "state of the art."

Game theory has also been applied to construction management in two areas. Ho (2001) applies game theory to analyze the information asymmetry problem during the procurement of a BOT project and its implication in project financing and government policy. Ho and Liu (2004) develop a game theoretic model for analyzing the behavioral dynamics of builders and owners in construction claims. In *PPPs*, conflicts and strategic interactions between public and private parties are common, and thus game theory can be a natural tool to analyze the problems of interest.

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. Note that "simultaneously" here means that the each player makes decision without knowing the decisions made by others. The bid compensation issues discussed in section 3 are modeled by static games. On the contrary, in a dynamic game, the players act sequentially. The financial renegotiation model proposed in section 4 is a dynamic game, where private parties and government take turns in making decisions after observing the other party's action. Note that the players of a game are assumed to be rational. This is one of the most important assumptions in most economic theories. In other words, it is assumed that the players will always try to maximize their payoffs.

A well-known example of a static game is the "prisoner's dilemma" as shown in Table 1. Two suspects are arrested and held in separate cells. If both of them confess, then they will be sentenced to jail for 6 years. If neither confesses, each will be sentenced for only 1 year. However, if one of them confesses and the other does not, then the honest one will be rewarded by being released (in jail for 0 year) and the other will be punished for 9 years in jail. Note that in each cell the first number represents player 1's payoff and the second one represents player 2's.

In a dynamic game, players move *sequentially* instead of simultaneously. It is more intuitive to represent a dynamic game by a tree-like structure, also called the "extensive form" representation. The concepts of dynamic games can be illustrated by the following simplified *Market Entry* example. A new firm, New Inc., wants to enter a market to compete with a monopoly firm, Old Inc. The monopoly firm does not want the new firm to enter the market, because new entry will reduce the old firm's profits. Therefore, Old Inc. threatens New Inc. with a price war if New Inc. enters the market. Figure 1 shows the extensive form of the market entry game. The game tree shows (1) New Inc. chooses to enter the market or not, and then Old Inc. chooses to start a price war or not, and (2) the payoff of each decision combination.

Table 1. Prisoner's Dilemma

		Player 2	
		Confess	Not confess
Player 1	Confess	(<u>-6</u>, <u>-6</u>)	(<u>0</u>, -9)
	Not confess	(-9, <u>0</u>)	(-1, -1)

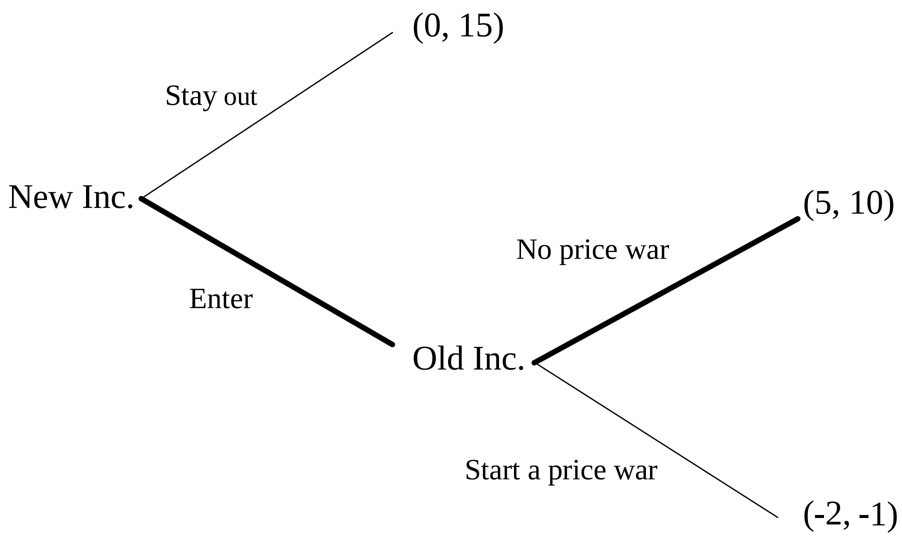

Fig. 1. Simplified Market Entry Game

To answer what each player will play/behave in a game, we will introduce the concept of "*Nash equilibrium*," one of the most important concepts in game theory. Nash equilibrium is a set of actions that will be chosen by each player. 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 "self-enforcing" (Gibbons, 1992). Conversely, a non-equilibrium solution is not stable since at least one of the players can be better off by deviating from the non-equilibrium solution. In the prisoner's dilemma, only the (confess, confess) solution where both players choose to confess, satisfies the stability test or requirement of Nash equilibrium. Note that although the (not confess, not confess) solution seems better off for both players compared to Nash equilibrium; however, this solution is unstable since either player can obtain extra benefit by deviating from this solution.

In the simplified dynamic market entry game, a intuitive conjecture of the solution of the Market Entry game is that New Inc. will "stay out" because Old Inc. threatens to "start a price war" if New Inc. plays "enter." However, Fig. 1 shows that the threat to start a price war is *not credible* because Old Inc. can only be worse off by starting a price war if New Inc. does enter. On the other hand, New Inc. knows the pretense of threat, and therefore will maximize the payoff by playing "enter." As a result, the Nash equilibrium of the market entry game is (enter, no price war), a strategically stable solution that does not rely on the player to carry out an incredible threat. Note that this simplified market entry game did not consider that there might be other new companies trying to enter if the old company did not maintain certain reputation regarding the credibility of threat. A dynamic game can be solved by maximizing each player's payoff *backward recursively* along the game tree (Gibbons, 1992). We shall apply this technique in solving the financial renegotiation game in *PPPs*.

Note that in the following analysis, certain degree of simplification and abstraction is necessary in theoretical modeling in order to obtain tractable and insightful results. The insights and qualitative implications from the model are often more important than the exact game solutions obtained. Therefore, it is not necessary to go through every detailed derivation in this chapter to understand the insights obtained from the models. Readers with limited mathematical background or without time to go through the mathematical details may choose to forego the equations and mainly focus on the qualitative implications and insights implied by those equations.

3. Is Bid Compensation Effective in *PPP* Tendering?

3.1 Bid Compensation Myth

An often seen suggestion in practice for projects with high bid preparation cost is that the owner should consider paying bid compensation, also called stipend or honorarium, to the unsuccessful bidders. For example, in a publication by DBIA (1995), it is stated that "it is strongly recommended that honorariums be offered to the unsuccessful proposers" and that "the provision of reasonable compensation will encourage the more sought-after design-build teams to apply and, if short-listed, to make an *extra effort* in the preparation of their proposal." Whereas bid preparation cost depends on project scale, delivery method and other factors, the cost of preparing a proposal is often relatively high in certain project delivery schemes, such as *PPPs*. Therefore, government's bid compensation policy or strategy in *PPPs* is important to practitioners and worth further investigation.

However, before Ho (2005), the bid compensation strategy for *PPP* projects has not been formally modeled in literature. Among the issues over the bidder's response to the owner's bid compensation strategy, it is owner's interest to understand whether the owner can stimulate high quality inputs or extra effort from the bidder during bid preparation and under what conditions. Whereas the argument for using bid compensation may be intuitively sound, there is no theoretical basis or empirical evidence for such argument. Therefore, it is crucial to study that under what conditions the bid compensation is effective, and that how much compensation is adequate with respect to different bidding situations. Based on the game theoretic analysis and numeric trials, a bid compensation model is developed. The model provides a quantitative framework as well as qualitative implications on bid compensation policy. The model may also help the owner form bid compensation strategies under various competition situations and project characteristics.

In short, a paradox exists in this model. On the one hand, the model solves the equilibrium conditions for effective bid compensation. On the other hand, through the practical implications of these conditions, it is shown that offering bid compensation is not very effective and thus not recommended in most cases. This conclusion is partly confirmed by Connolly (2006) in his discussion paper, in which he stated that "the discusser [Connolly] has found payment of bid compensation on large international construction projects to be counterproductive in several sectors."

3.2 Bid Compensation Model

This section gives the major details of model derivation, while the complete details can be found in Ho (2005). Illustrative examples with numerical results are given when necessary to show how the model can be used in various scenarios.

3.2.1 Assumptions and Model Setup

To perform a game theoretic study, it is critical to make necessary simplifications so that one can focus on the issues of concern and obtain insightful results. Then the setup of a model will follow. The assumptions made in this model are summarized as follows. Note that these assumptions can be relaxed for more general purposes.

1. Average bidders: The bidders are equally good, in terms of their technical and managerial capabilities. Since the *PPPs* focuse on quality issues, the pre-qualification process imposed during procurement reduces the variation of the quality of bidders. As a result, it is not unreasonable to make the “average bidders” assumption.

2. Bid compensation for the second best bidder: We shall assume that the bid compensation will be offered to the second best bidder, i.e., the highly ranked unsuccessful bidder.

3. Two levels of efforts: It is assumed that there are two levels of efforts in preparing a proposal, high and average, denoted by H and A, respectively. The effort A is defined as the level of effort that does not incur extra cost to improve quality. Contrarily, the effort H is defined as the level of effort that will incur extra cost, denoted as E, to improve the quality of a proposal, where the improvement is detectable by an effective proposal evaluation system, for example, the evaluation criteria and the respective weights specified in Request for Proposal.

4. Fixed amount of bid compensation, S: The fixed amount can be expressed by a certain percentage of the average profit, denoted as P, assumed during the procurement by an average bidder.

5. Absorption of extra cost, E: For convenience, it is assumed that E will not be included in the bid price so that the high effort bidder will win the contract under the price-quality competition, such as best-value approach. This assumption simplifies the trade-off between quality improvement and bid price increase.

3.2.2 Two-Bidder Game

In this game, there are only two qualified bidders. The possible payoffs for each bidder in the game are shown in a normal form in Table 2. If both bidders choose “H,” denoted by (H, H), both bidders will have 50% probability of wining the contract, and at the same time, have another 50% probability of losing the contract but being rewarded with the bid compensation, S. As a result, the expected payoffs for the bidders in (H, H) solution are (S/2+P/2-E, S/2+P/2-E). Note that the computation of the expected payoff is based on the assumption of the average bidder. Similarly, if the bidders choose (A, A), the expected payoffs will be (S/2+P/2, S/2+P/2).

If the bidders choose (H, A), bidder 1 will have 100% probability of winning the contract, and thus the expected payoffs are (P-E, S). Similarly, if the bidders choose (A, H), the expected payoffs will be (S, P-E). Payoffs of an n-bidder game can be obtained by the same reasoning.

Since the payoffs in each equilibrium are expressed as functions of S, P, and E, instead of a particular number, the model will focus on the conditions for each possible Nash equilibrium of the game. Here, the approach to solving for Nash equilibrium is to find conditions that ensure the stability or self-enforcing requirement of Nash equilibrium.

First, check the payoffs of (H, H) solution. For bidder 1 or 2 not to deviate from this solution, we must have

$$S/2+P/2-E > S \Rightarrow S < P-2E \qquad (1)$$

Therefore, condition (1) guarantees (H, H) to be a Nash equilibrium. Second, check the payoffs of (A, A) solution. For bidder 1 or 2 not to deviate from (A, A), condition (2) must be satisfied.

$$S/2+P/2 > P-E \Rightarrow S > P-2E \qquad (2)$$

Thus, condition (2) guarantees (A, A) to be a Nash equilibrium. Note that the condition "S = P-2E" will be ignored since the condition can become (1) or (2) by adding or subtracting an infinitely small positive number. Thus, since S must satisfy either condition (1) or condition (2), either (H, H) or (A, A) must be a unique Nash equilibrium. Third, check the payoffs of (H, A) solution. For bidder 1 not to deviate from H to A, we must have P-E > S/2+P/2; i.e., S < P-2E. For bidder 2 not to deviate from A to H, we must have S > S/2+P/2-E; i.e., S > P-2E. Since S cannot be greater than and less than P-2E at the same time, (H, A) solution cannot exist. Similarly, (A, H) solution cannot exist either. This also confirms the previous conclusion that either (H, H) or (A, A) must be a unique Nash equilibrium.

Table 2. Two-Bidder Game

		Bidder 2: H	Bidder 2: A
Bidder 1	H	(S/2+P/2-E, S/2+P/2-E)	(P-E, S)
	A	(S, P-E)	(S/2+P/2, S/2+P/2)

Bid compensation is designed to serve as an incentive to induce bidders to make high effort. Therefore, the concerns of bid compensation strategy should focus on whether S can induce high effort and how effective it is. According to the equilibrium solutions, the bid compensation decision should depend on the magnitude of P-2E or the relative magnitude of E compared to P. If E is relatively small such that P > 2E, then P-2E will be positive and condition (1) will be satisfied even when S = 0. This means that bid compensation is not an incentive for high effort when the extra cost of high effort is relatively low. Moreover, surprisingly S can be damaging when S is high enough that S > P-2E.

On the other hand, if E is relatively large so that P-2E is negative, then condition (2) will always be satisfied since S cannot be negative. In this case, (A, A) will be a unique Nash equilibrium. In other words, when E is relatively large, it is not in the bidder's interest to incur extra cost on improving the quality of proposal, and therefore, S cannot provide any incentives for high effort.

To summarize, when E is relatively low, it is in the bidder's interest to make high effort even if there is no bid compensation. When E is relatively high, the bidder will be better off by making average effort. In other words, bid compensation cannot promote extra effort in a two-bidder game, and ironically, bid compensation may discourage high effort if the compensation is too much. Thus, in the two-bidder procurement, the owner should *not* use bid compensation as an incentive to induce high effort.

3.2.3 Three-Bidder Game

Table 3 shows all the combinations of actions and their respective payoffs in a three-bidder game. Similar to the two-bidder game, here the Nash equilibrium can be solved by ensuring the stability of the solution. We shall forego the detailed derivation and associated equations here. Readers may refer to Ho (2005) for details. There are four possible equilibrium, (H, H, H), (A, A, A), (2H+1A), and (1H+2A), where the last two equilibrium are so called “mix strategy Nash equilibrium.” According to the concept of “mix strategy,” 2H+1A means that each bidder randomizes actions between H and A with certain probabilities, and the probability of choosing H in 2H+1A is higher than that in 1H+2A. From this perspective, the difference between 2H+1A and 1H+2A is not very distinctive. In other words, one should not consider, for example, 2H+1A, to be two bidders playing H and one bidder playing A; instead, one should consider each bidder to be playing H with higher probability. Similarly, 1H+2A means that the bidder has lower probability of playing H, compared to 2H+1A.

Table 3. Three-Bidder Game

Bidder 3	H		A	
Bidder 2	H	A	H	A
Bidder 1 H	(S/3+P/3-E, S/3+P/3-E, S/3+P/3-E)	(S/2+P/2-E, 0, S/2+P/2-E)	(S/2+P/2-E, S/2+P/2-E, 0)	(P-E, S/2, S/2)
Bidder 1 A	(0, S/2+P/2-E, S/2+P/2-E)	(S/2, S/2, P-E)	(S/2, P-E, S/2)	(S/3+P/3, S/3+P/3, S/3+P/3)

3.2.4 Illustrative Example: The Effectiveness of Bid Compensation

The equilibrium conditions for a three-bidder game is numerically illustrated and shown in Table 4, where P is arbitrarily assumed as 10% for numerical computation purpose and E varies to represent different costs for higher efforts. The “ * ” in Table 4 indicates that zero compensation is the best strategy; i.e., bid compensation is ineffective in terms of stimulating extra effort. According to the numerical results, Table 4 shows that bid compensation can promote higher effort only when E is within the range of P/3<E<P/2, where zero compensation is not necessarily the best strategy. The question is that whether it is beneficial to the owner by incurring the cost of bid compensation when P/3<E<P/2. The answer to this question lies in the concept and definition of the mix strategy Nash equilibrium, 2H+1A, as explained previously. Since 2H+1A indicates that each bidder will play H with significantly higher probability, 2H+1A may already be good enough, knowing that we only need one bidder out of three to actually play H. We shall elaborate on this concept later in a more general setting. As a result, if the 2H+1A equilibrium is good enough, the use of bid compensation in a three-bidder game will not be recommended.

Table 4. Compensation Impacts on a Three-Bidder Game
(* denotes that zero compensation is the best strategy)

Equilibrium / E; P=10%	3H	2H+1A	1H+2A	3A
E < P/3 e.g. E=2%	S < 14% *	N/A	N/A	14% < S
P/3 < E < P/2 e.g. E=4%	2% < S < 8%	S < 2%	N/A	8% < S
P/2 < E < (2/3)P e.g. E=5.5%	N/A	N/A	S < 3.5% *	3.5% < S
(2/3)P < E e.g. E=7%	N/A	N/A	N/A	Always *

3.3 Nash Equilibrium of N-Bidder Game

It is desirable to generalize our model to the n-bidder game for more general purposes, although only limited qualified bidders will be involved in most *PPP* procurements. We will also explain the mix strategy concept in details. We show that in most cases bid compensation can only offer limited benefits to the owner, compared to the cost of compensation.

3.3.1 Mixed Strategy Nash Equilibrium

As mentioned earlier, in a mixed strategy, players randomize actions H and A with certain probability to confound other players. From a more dynamic perspective, every player observes which strategy works and the player would change his strategy if the one currently used does not perform as well as other strategies. This strategy-adjusting process continues until the proportion of players in the population who play a particular strategy is equal to the mixed strategy Nash equilibrium probability. A mixed strategy can occur when there are multiple pure strategy equilibria or when there is no pure strategy equilibrium. In fact, a pure strategy equilibrium can be considered a mixed strategy equilibrium with 100% probability of playing the pure strategy. Therefore, the major concern in mixed strategy equilibrium is the probability of playing each strategy.

Table 5. Sale Competition Game

		Store 2 Sale (w/p λ)	No Sale (w/p $1-\lambda$)
Store 1	Sale	(300, 300)	(700, 400)
	No Sale	(400, 700)	(500, 500)

In the bid compensation problem, one main issue is how to compute the probabilities for choosing actions H and A. A simple example, Sale Competition Game, shown in Table 5, illustrates how the mixed strategy probabilities are solved. Suppose that two stores are considering whether they should have a winter sale. If both stores run the sale, the payoffs would be \$300 for each because of intensive price competition. If none of the stores has a sale, the payoffs would be \$500 for each. If there is only one store on sale, then the payoffs would be \$700 and \$400 for the on-sale store and the regular store, respectively. We find that there are two pure strategy equilibria in the Sale game, (Sale, No Sale) and (No Sale, Sale), where no player has an incentive to change. However, it is difficult to explain why there is a player who would always choose "No Sale." In fact, there is a better equilibrium, the mixed strategy equilibrium, where each store will randomize "Sale" and "No Sale" with certain probabilities. The probabilities can be solved by following the definition of mixed strategy Nash equilibrium. According to Gibbons (1992), in a two-player game, a mix strategies are a Nash equilibrium if each player's mixed strategy is a best response to the other player's mixed strategy. In the sale game, suppose "λ" is the probability that store 2 has a sale and λ is known by store 1, then store 1's expected payoffs are (λ)300+(1-λ)700 from playing "Sale" and (λ)400+(1-λ)500 from playing "No Sale." As a result, if λ>2/3 then store 1's best response is to play "No Sale," if λ<2/3 then store 1's best response is to play "Sale," and if λ=2/3 then store 1's best response is to play either strategy with any probabilities. In other words, when λ=2/3 store 1 can choose any mixed strategies as a best response to store 2's mix strategy. In this regard, half of the equilibrium definition is satisfied. Logically, if we also find a mix strategy for store 1 such that store 2's best response is to play any mixed strategies, then the equilibrium definition "each player's mixed strategy is a best response to the other player's mixed strategy" will be satisfied. Thus, the mathematical requirement for the mix strategy Nash equilibrium is that each player's mix strategy probabilities will make the other player indifferent between potential strategies. Since the Sale game is symmetric; i.e., the payoff patterns for store 1 and 2 are identical, the mixed strategy probability for store 1 to choose "Sale" is also 2/3. Thus, the mixed strategy Nash equilibrium of the Sale game is that each store will choose "Sale" with a probability of 2/3 and "No Sale" with a probability of 1/3.

3.3.2 Mixed Strategy Nash Equilibrium in the N-Bidder Game

Numerical method, such as trials-and-errors, will be needed for solving the probability. For an n-bidder game of symmetric payoffs, we can find the mixed strategy probability, q^*, can be obtained by solving equation (10).

$$(1-q^*)^{n-1}(P-E)+\sum_{i=2}^{n}\left[(q^*)^{i-1}(1-q^*)^{n-i}C_{i-1}^{n-1}(\frac{S}{i}+\frac{P}{i}-E)\right]=$$

$$(1-q^*)^{n-1}(\frac{S}{n}+\frac{P}{n})+q^*(1-q^*)^{n-2}(n-1)(\frac{S}{n-1}) \qquad (3)$$

where C_{i-1}^{n-1} is the number of combinations of *n*-1 things choosing *i*-1.

The left hand side (LHS) of equation (3) is the bidder's expected payoff by choosing H, giving that each of the competing bidders plays H and A with probabilities q and 1-q, respectively. The first term of LHS is the bidder's expected payoff when all competitors play A. The second term of LHS sums up the bidder's expected payoff with (n-*i*) competitors playing A and (*i*-1) competitors playing H, with C_{i-1}^{n-1} different combinations for each *i*. The right hand side (RHS) is the bidder's expected payoff by choosing A. The first term of RHS is the bidder's payoff when all competitors play A. The second term is the bidder's payoff when there is only a competitor playing H. When there are at least two competitors playing H, the bidder's expected payoff would be zero. A computer program was developed to solve equation (3) numerically. Table 6 shows some mixed strategy probabilities with respect to various S. For example, when E is equal to 5.5% and in the range of P/2<E<(3/5)P, the probability of choosing H without compensation, q^* will be 0.296. If the compensation is designated to cover all extra cost; i.e., S = 5.5%, then q^* will be equal to 0.457. On the other hand, when E is smaller, e.g., E = 4%, q^* will be equal to 0.578 without compensation, significantly larger than the aforementioned probability with E=5.5%.

Table 6. Mixed Strategy Probabilities in a Four-Bidder Game

Equilibrium / E ; P=10%	4H	3H+1A	2H+2A	1H+3A	4A
E < P/4 e.g. E=2%	S < 22%	N/A	N/A	N/A	S > 22%
P/4 < E < P/3 e.g. E=3%	2% < S <18%	0 < S < 2% ***S=0, q=0.829*** ***S=1%, q=0.914***	N/A	N/A	S > 18%
P/3 < E < P/2 e.g. E=4%	6% < S <14%	2% < S < 6% ***S=2%, q=0.697*** ***S=4%, q=0.854***	S < 2% ***S=0, q=0.578*** ***S=1%, q=0.632***	N/A	S > 14%
P/2<E<(3/5)P e.g. E=5.5%	N/A	6.5% < S <8% ***S=6.5%, q=0.550*** ***S=7.5%, q=0.661***	3% < S < 6.5% ***S=3%, q=0.341*** ***S=5.5%, q=0.457***	S < 3% ***S=0, q=0.296*** ***S=1%, q=0.306***	S > 8%
(3/5)P<E<(3/4)P e.g. E=6.5%	N/A	N/A	N/A	S < 4% ***S=0, q=0.140*** ***S=2%, q=0.102***	S > 4%
(3/4)P < E	N/A	N/A	N/A	N/A	ALWAYS

3.3.3 Optimal Bid Compensation Decisions

As argued previously, it is assumed that the owner's evaluation criteria are effective so that a higher quality proposal can be identified and awarded by the owner. As a result, the owner will only need *one*, instead of all, high effort bidder during procurement; i.e., the major concern of the owner will be the probability that there is at least one bidder with effort H, which is computed by equation (4). Equation (4) shows that the probability of having at least one H bidder, p, expressed as a function of S, can be computed by one minus the probability of not having a single H bidder.

$$p(\mathrm{S})=1-[1-q^{*}(\mathrm{S})]^{n} \tag{4}$$

In a three-bidder game, when E equals 4% as shown in Table 4, according to equation (3), q^{*} will be equal to 0.8 for S=0. By equation (4), we know that p(S=0) = 0.992, which confirms our previous conjecture that the 2H+1A mixed strategy is good enough in a thee-bidder game and bid compensation should not be used in a three-bidder game.

Figure 2 shows the values of p with respect to different values of q^* in a two-, three-, four-, and five-bidder procurement. For example, if the owner wants p to be 0.97, the requirements for q in the cases of two, three, four and five bidders are approximately 0.83, 0.7, 0.6, and 0.5, respectively. Although q^* will be equal to 1 only in the nH equilibrium, Fig. 2 shows that when there are at least three bidders, the mixed strategy equilibrium tends to become a satisfactory solution. The examples in Table 6 show that when n = 4 and E = 4%, p will be equal to 0.968 for S=0 even though q^* only equals 0.578. As a result, bid compensation is not necessary in this case. For another case, when E grows to 5.5%, p will be equal to 0.754 for S=0, and thus bid compensation becomes more effective. In this case, p will be increased from 0.754 to 0.913 with S=5.5%. However, the owner may not be better off by offering S=5.5% in exchange for a higher p.

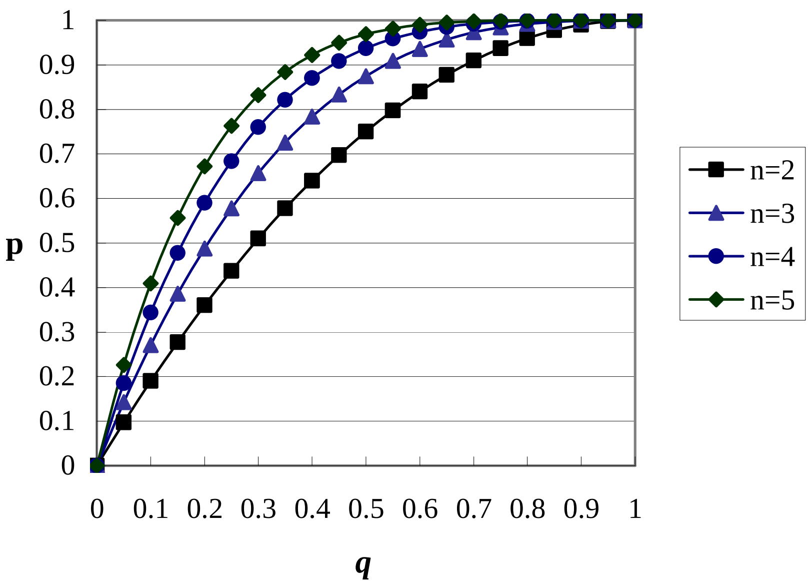

Fig. 2. Probability *p* Versus Probability *q* for Different Numbers of Bidders

The issue now is how to determine whether a certain amount of bid compensation, S, is appropriate. It is argued from the economic perspective that an appropriate S should be justified by the marginal benefit obtained through the increase of *p*. Therefore, it is suggested that the owner should determine the magnitude of bid compensation according to the objective function in equation (5).

$$B = \underset{S}{Max}\ \{\ [p(\mathrm{S})\text{-}\ p(S\text{=}0)](\Gamma_H - \Gamma_A) - \mathrm{S}\ \} \tag{5}$$

where Γ_H and Γ_A are the net values of a project to the owner with effort H and effort A, respectively. $\Gamma_H - \Gamma_A$, the marginal benefit due to higher effort, can be expressed as a percentage of total cost, so to be consistent with the expressions of E and S. For previous example, when n=4 and E=5.5%, if $\Gamma_H - \Gamma_A$ equals 20%, *B* will be maximized when S=0 according to the equation (5). Thus, in this case, it is not in the owner's interest to use bid compensation to promote higher effort.

Note that equation (5) implies or assumes that the owner has to award the project to a bidder even when all bidders invest effort A. This is true when it is very costly to reprocure a project. Thus, for a large scale project or complex project, the implicit assumption in equation (5) should be reasonable. However, if it is allowed to award no bidder and reprocure a project until the H bidder appears, the cost-benefit analysis must be evaluated differently. Specifically, the owner's cost of project procurement and the expected rounds of procurement should be considered.

3.4 Bid Compensation Policy in *PPP* Procurement

The bid compensation policy are based on the analyses of games of two, three, four, and n (n>4) bidders. The bid compensation model provides the owner or government a theoretical framework for bid compensation decisions. Note that although the equilibrium conditions for effective bid compensation are solved, it does not mean that the model supports the use of bid compensation.

Four important policy implications on *PPP* bid compensation are concluded:

1. *Inappropriate use of bid compensation could discourage high effort*.

2. *The bid compensation strategies can be regarded as a problem of three-dimensions: the number of bidders, the complexity of project, and the project profitability*. Project complexity can be characterized by how much extra effort is needed for improvement, which is defined as E in this model. Project profitability, denoted as P in this model, is the expected profit before compensation.

3. *Bid compensation is not desirable when the cost of extra effort, E, is very small or large compared to the expected profit margin before compensation.* More specifically, bid compensation is not recommended for two- or three-bidder procurement because of the ineffectiveness of compensation, no matter how simple or complex the project is. When there are four or more bidders, bid compensation becomes more effective in promoting higher effort.

4. *It is not necessarily better off to use bid compensation even when the bid compensation becomes more effective in stimulating higher effort*. In fact, the final decisions of whether to use bid compensation and the amount of compensation should be judged by the marginal cost-benefit analysis as indicated in equation (5).

To conclude, it is worth noting that in *PPP* projects it is not unusual that the number of bidders is limited to two or three. In this case, the owner or government should not use bid compensation as an incentive. For those projects with minimum complexity and small contract profit margin, such as highways or factory plants, the use of bid compensation is not recommended either, even when the bidders are more than three. The use of bid compensation could be considered only when there are more than three bidders and the costs for high effort are moderate, not too high compared to the profit margin.

Lastly, there is a paradox in the proposed decision model. On one hand, the model solves the equilibrium conditions for effective bid compensation. On the other hand, through the practical implications of these conditions, it is shown that the offering of bid compensation is not recommended in most cases. Hence, better incentive mechanisms that are more effective than offering bid compensation may be desired. In fact, extra effort invested in a bid by the contractor does not equal bid quality improvement, since those extra efforts may not be consistent with the owner’s needs. From this perspective, the bid compensation mechanism is a passive approach, without the owner's proactive participation. Are there alternatives to bid compensation with higher onwer's participation? Yes. Possible alternatives include the one suggested in Connolly (2006): "one of the variations now in use on the design–build lump sum turnkey delivery system is the design competition, in which the owner pays the bidders, usually at rates, to develop their individual concepts to the point where the documents are the technical scope for use [in a bid request]…Variations of the method have the owner choosing the concept that is best in the owner's view, and all contractors bidding that one as the basis."

4. Financial Renegotiation Problems and the Implied Administration Policies

The fact that government may rescue a distressed project and renegotiate with the developer causes major problems in project procurement and management. The dilemma faced by government is that although financial renegotiation is not considered an option in the contract before project distress, but is often desirable after the distress. Such time inconsistency creates serious problems in project administration. Here a game theory based model is proposed to analyze government's procurement and management policies from the perspective of renegotiation. The results will provide theoretic foundations and guidelines for examining the effectiveness of government's procurement and management policies in *PPPs*.

4.1 Problmes Caused by Financial Renegotiation

The joint ownership or partnership in *PPPs* complicates the project administration, particularly in project procurement and contract management. Financial renegotiation in this chapter refers to the rescuing financial subsidy negotiation after the contract being signed, when conditions change unfavorably and significantly. In *PPPs*, financial renegotiation may happen when project cost, market demand, or other market conditions become significantly unfavorable. The fact that government may bail out a distressed project and renegotiate with the developer in *PPPs* causes serious opportunism problems in project administration.

- The first problem is the opportunistic bidding behavior during project procurement. In this section, opportunistic bidding behavior in *PPPs* refers to that the bidders, in their proposals, intentionally understate possible risks involved or overstate the project profitability in order to outperform other bidders. In their pilot study, Ho and Liu (2004) developed a game theoretic Claims Decision Model (CDM) for analyzing the behavioral dynamics of builders and owners in construction claims and the implications on opportunistic bidding. Their model shows that if a builder can easily make an effective construction claim, the builder will have incentives to bid opportunistically. In *PPPs*, a successful request for renegotiation is analogous to an effective claim. In other words, if the request for renegotiation is always granted, the developers would then have incentives to bid optimistically to win the project. The reason that an overly optimistic proposal can have a higher chance of winning is because some crucial and developer-specific information regarding the project is difficult to be verified by government and, as a result, can be untruthfully revealed in the development proposal. That is, some important information is *asymmetric* to government. For example, the developer's cost and profit structures, the project's commercial and technical risk, and the risk impacts may not be fully revealed in, or consistent with, the developer's bid proposal. Because of the information asymmetry in *PPPs*, opportunistic bidding may succeed during procurement. Therefore, if the developers have incentives to bid opportunistically due to the *ex ante* expectation of *ex post* renegotiation, the effectiveness of project procurement and contract management will be influenced significantly. Since this logic between government rescue and project administration effectiveness is not straightforward, the importance of financial renegotiation problem is underemphasized.

- The second opportunism problem is the Principal-Agent problem, where the Principal is played by government and the Agent is played by the developers. This problem is also regarded as Moral Hazard problem, which happens only after the contract is signed. In his repossession game example, Rasmusen (2001) shows that if renegotiation is expected, the agent may choose inefficient actions that will reduce overall or social efficiency, but increase the agent's payoff. In *PPPs*, after signing the concession, moral hazard problems will also occur if renegotiation is expected. For example, given in practice that the developers are often the major contractors or suppliers of the *PPP* project, the developers may not be concerned too much about project cost overrun because the contractors may benefit from such overspending.

In short, if government always bails out a financially distressed project, renegotiation will be expected by developers and such expectation can cause opportunism problems. Unfortunately, government is often temped to bail out distressed projects because of the *ex post* renegotiation benefits to government and/or the society. The dilemma faced by government is that although financial renegotiation is not considered an option in the contract before project distress, but is often desirable after the distress. Such time inconsistency creates incentives for opportunism and problems in project administration.

4.2 Game and its Equilibrium of Financial Renegotiation

The behavioral dynamics of the renegotiation or government rescue plays a central role in *PPP* administration when information asymmetry exists. Here, game theory is applied to analyze when government will renegotiate with the developer and the impacts of such renegotiation on the project. While this study is motivated by real world cases from various countries and the author's personal consulting experiences, the goal of this model is to provide a framework that is not restricted to particular environment. In other words, the model is expected to consider various environments characterized by the parameters of the model.

4.2.1 Model Setup

The game theoretic framework for analyzing a *PPP* investment shown in Fig. 3 is a dynamic game expressed in an extensive form. Suppose a *PPP* contract does not specify any government rescue or subsidies in the face of financial crisis. Neither does the law prohibit government from bailing out the *PPP* project by providing debt guarantee or extending the concession period. Suppose also that government is not encouraged to rescue a project without compelling and justifiable reasons. For example, cost overrun or operation losses caused by inefficient management or normal business risk should not be justified for government rescue, whereas adverse events caused by unexpected or unusual equipment/material price escalation may be justified more easily. Thus, it should be reasonable to assume that if government grants a subsidy to a project on the basis of unjustifiable reasons, government may suffer from the loss of public trust or the suspicion of corruption.

The dynamic game, as shown in Fig. 3, starts from adverse situations where it is in the developer's (denoted by D in the game tree) or lending bank's best interests to bankrupt 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 specify any possible future rescue from government. Here U is defined as the present value of the net financial viability change, and is considered as the maximum possible requested subsidy. Note that U is not the actual subsidy amount. Instead, the actual subsidy is determined in the renegotiation process discussed later.

If the developer chooses project bankruptcy, the payoff will be $-\delta$. Here it is assumed $\delta \to 0$. The main reason is that if the situations call for bankruptcy, the value of the *equity shares* held by the developer should approach zero before project bankruptcy; therefore, the developer, being an equity holder, will lose little if the distressed project is bankrupted. Thus, it is assumed that $\delta = 0$ in the model. Note that some may argue that δ is significant due to the loss of reputation. However, the loss of reputation occurs when the project is in distress, no matter the developer chooses to request rescue subsidies or project bankruptcy. Therefore, if δ is defined as bankruptcy payoff, then δ should not be regarded as the loss of reputation. The consideration of reputation loss could be another parallel approach that may discourage opportunistic behaviors. The effect of this parallel strategy, from the game theoretic perspective, is beyond the scope of the model.

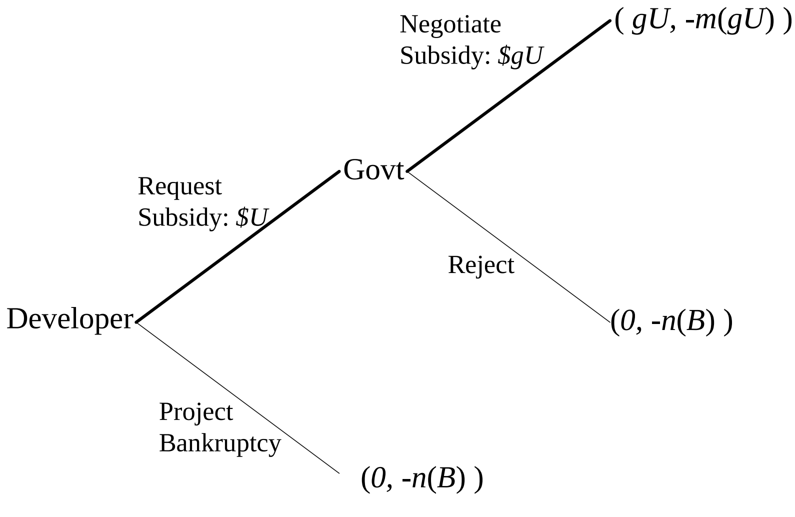

Fig. 3. Renegotiation Game's Equilibrium Path

On the other hand, if a *PPP* project is bankrupted, the payoff of government is $-n(B)$, where *B* is government's "budget overspending" when a project is bankrupted and retendered, and *n*, a function of *B*, is the *political cost due to project retendering*. Generally, from either a financial or political perspective, it is costly for government if a *PPP* project is bankrupted. Suppose that for a *PPP* project to proceed beyond procurement stage, the project must have shown to provide the facilities or services that can be justified economically. Then it is reasonable to assume that a bankrupted *PPP* project should be regained by government and retendered to another new developer, unless, in rare occasions, the marginal subsidy for improving project financial viability is greater than the net benefits from the facility/service. Logically, for government to "permanently" terminate a project without retendering, after spending millions or billions of dollars, would only signify that the project was not worth undertaking in the beginning and that a serious mistake was made by government during the project procurement. Therefore, in this game, it is assumed that retendering is desired by government if a project is going bankrupt.

Alternatively, as shown in Fig. 3, the developer can negotiate a subsidy starting with the maximum amount $*U*, where the subsidy can be in various forms such as debt guarantee or concession period extension. Typically, in a financial distress, the bank will not provide extra capital needs without government debt guarantee or other subsidies. Because the debt guarantee is a liability to government, but an asset to the developer, debt guarantee is equivalent to a subsidy from government. Other forms of subsidy may include the extension of concession period, more tax exemption for a certain number of years, or extra loan or equity investment directly from government.

After the developer's request for subsidy, the game proceeds, as shown in Fig. 3, to its subgame: "negotiate subsidy" or "reject." If the government rejects the developer's request, the project will be bankrupted and retendered 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 although the political cost, *m*, is also a function of budgeting spending, function *m* is different from function *n*, because in the two functions the budget spending goes to different parties. To rescue a *PPP* project and provide rescuing subsidy to the original *PPP* firm could bring serious criticism toward government. If government lacks compelling reasons for the subsidy, the criticism will cause significant *political* cost depending on the magnitude of the subsidy. We shall discuss the differences between the two functions in details later. Also note that here g is not a constant and is used to model the process of "offer" and "counter-offer." More details on the negotiation modeling using g can be found in Ho and Liu (2004).

4.2.2 "Rescue" or "No Rescue:" Nash Equilibria of the Rescue Game

As mentioned previously, the financial renegotiation game tree derived above will be solved backward recursively and its Nash equilibrium solutions will be obtained. Since the values for the variables in the game's payoff matrix are undetermined, the payoff comparison and maximization cannot be done to solve for a unique solution. However, we can analyze the conditions for possible Nash equilibria of the game. There are three candidates for the Nash equilibria: (1) developer will "request subsidy," and government will "negotiate subsidy," (2) developer will "request subsidy" and government will "reject," and (3) developer will choose "project bankruptcy."

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

   Here, since government chooses to "negotiate subsidy," this equilibrium is called "rescue" equilibrium in this model. 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

   $$m(gU) \leq n(B) \tag{6}$$

   This condition is straightforward: the political cost of rescue should be less than or equal to the political cost for not rescuing the project. As indicated by the latter bold line in Fig. 3, the payoff for the developer and government will now be $(gU, -m(gU))$, respectively.

   The next step is to solve Fig. 3 backward again, at the developer's node, and obtain the final solution. Now the payoffs for "request subsidy" are $(gU, -m(gU))$, and the developer will request subsidy if $gU \geq 0$. Since g and U will not be negative numbers, the condition for the developer to request subsidy will always be satisfied. In other words, it is always to the developer's benefit to negotiate subsidy if equation (6) is satisfied.

   Figure 3 also shows the equilibrium path expressed in bold lines that goes through the game tree. Note that when the developer requests subsidy for U, the final settlement for the subsidy will be a portion of U, gU, which satisfies equation (6). From equation (6), 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, and we will discuss this further in other sections.

2. Developer will "request subsidy" and government will "reject."

   If equation (6) is not satisfied, "reject" would be a preferable decision to government, and the payoff matrix for both parties is (0, $-n(B)$). Now turn to the developer's node: it seems that the payoff of either "request subsidy" or "project bankruptcy" is $\$0$, and the developer is indifferent between the two actions. From the game tree, it is not obvious which action the developer will choose. However, if the developer recognizes the existence of the cost incurred in the process of requesting subsidy, although it may be relatively small compared to other variables in the game tree, the developer should choose "project bankruptcy," instead of requesting subsidy. From this perspective, although the cost of requesting subsidy is suppressed in the game tree for clarity, the cost of requesting subsidy should be recognized whenever there is a tie between "request subsidy" and "project bankruptcy." To summarize, if the developer knows government will "reject" the subsidy request, the developer will choose "project bankruptcy," instead of "request subsidy" in the first place, and this is exactly the third possible equilibrium, "project bankruptcy." Thus, the second equilibrium solution cannot exist.

3. Developer chooses "project bankruptcy."

   Here, since the developer knows that government will choose to "reject" the subsidy request, the developer will choose project bankruptcy in the first place. We shall term this equilibrium the "no rescue" equilibrium. As argued above, the developer will choose project bankruptcy if and only if it is optimal for government to "reject" the subsidy request. Therefore, the condition of this Nash equilibrium would be

$$m(gU) > n(\mathrm{B}) \tag{7}$$

   In other words, for "project bankruptcy" to be an equilibrium solution, it must be that it is impossible to achieve the "rescue" solution. Equation (15) can be rewritten as

$$n(B) - m(gU) < 0 \tag{8}$$

To conclude this section, we find equations (6) and (8) for the *PPP* rescue game's "rescue" and "no rescue" equilibria, respectively. Both equilibria depend solely on the knowledge of government's political cost for rejecting a subsidy and granting a subsidy. We shall assume that the *PPP* game is a game with *complete information*, where $n(B)$ and $m(gU)$ are common knowledge and both parties know that the other party is equally rational and smart. Note that from the practical perspective, it is not easy for both parties to quantify $n(B)$ and $m(gU)$, because it is difficult to measure political cost in terms of monetary units. Fortunately, the game depicted above can still be analyzed without knowing the exact functions for $n(B)$ and $m(gU)$, and such game theoretic analysis can still lead to important qualitative and quantitative implications on *PPP* policies and decision making.

4.2.3 Modeling of Game Parameters

To perform this analysis, we need to examine the characteristics of the *PPP* project, especially its bankruptcy conditions and the political costs associated with bankruptcy.

- *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

$$m(gU) = \begin{cases} \beta(gU) & \text{if } gU \leq J \\ \beta(gU) + \rho_s(gU) & \text{if } gU > J \end{cases} \qquad (9)$$

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. The subscript "s" of $\rho_s(gU)$ denotes subsidy.

The modeling of the political cost of subsidy in equation (9) is based on the most fundamental concept in economics that resources are scarce. If government has unlimited funds to spend, there would be no political cost for negotiated subsidy. Since government only has limited budget to allocate, there will be political cost to government should the funds not be allocated appropriately. The more the subsidy is, the higher the political cost should be. As a result, the political cost of subsidy should be an increasing function of the amount of subsidy, *gU*. In equation (9), the political cost is further broken down into two elements, namely, $\beta(gU)$ and $\rho_s(gU)$. $\beta(gU)$, as illustrated in Fig. 4, 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. Alternatively, *J* can be measured by imagining that if the request goes to court, what amount of "claim" by the developer the court will grant. For example, usually the damages due to force majeur might be considered justifiable. 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 the basic political cost, $\beta(gU)$. Figure 5 also illustrates the function of the political cost of oversubsidization, $\rho_s(gU)$. It is worth noting that the shapes of the functions in Fig. 4 are for illustration purpose. The functions need not to be continuous or convex. The only requirement is that these functions are strictly increasing. Figure 5 shows the function $m(gU)$ obtained by combing the curves in Fig. 4 as defined in equation (9).

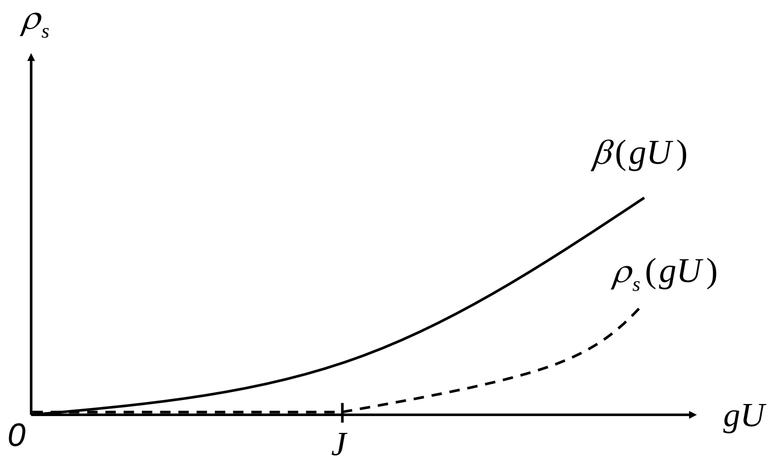

Fig. 4. Political Cost Function of Budgeting Overspending, $\beta(gU)$, and Political Cost Function of Oversubsidization, $\rho_S(gU)$

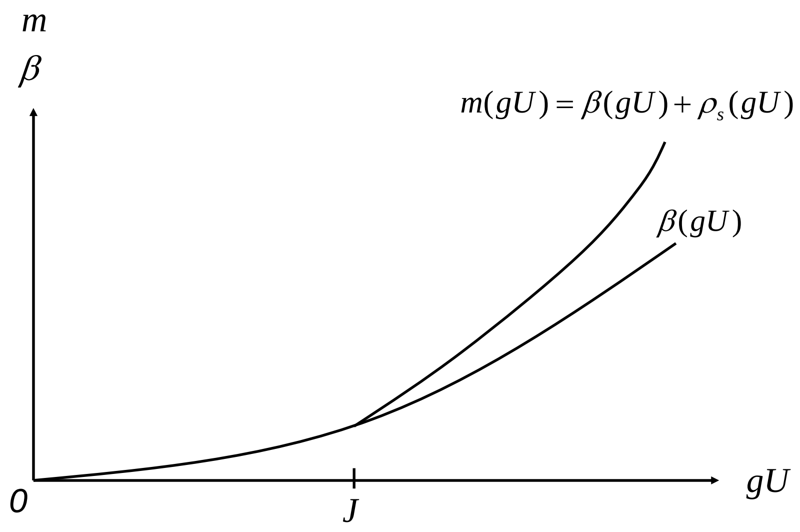

Fig. 5. Political Cost Function of Rescuing a Project, $m(gU)$

- *Political Cost of Retendering a Project*

To analyze the adverse conditions that place a *PPP* project on the edge of bankruptcy, we need some concepts of the bankruptcy mechanism. A very common bankruptcy condition in debt indenture is the inability of the borrower to meet the repayment schedule. In *PPPs*, the lending bank will also impose certain conditions to trigger bankruptcy and protect the loan should adverse events happen. For example, the lenders could specify the upper limit of cost overrun during the project development or construction. According to financial theory, rational lenders will prevent the *net value of the project up to current progress* from being below the *up-to-date debt outstanding*. Since project value and cost may be volatile from time to time during project life cycle, to ensure the security of debt, lenders need to evaluate the project viability and debt security periodically in terms of project's gross value and required debt.

If we assume that the lending bank can effectively monitor the project financial status, we may infer that at the time of bankruptcy, the overall value of the project will be less than but close to the estimated total outstanding debt. As a result, under near bankruptcy conditions, it is not wise for the bank to continue providing additional capital, because it is likely that the *PPP* firm will not be able to repay any further borrowing. Unless government guarantees the repayment of the loan, or secures the additional debt by other means, the lending bank will deny further capital request, even when such capital is still within project's original loan contract.

When a project is bankrupted, it will be considered "sold" to government and retendered to some other private developer given the assumption made earlier that the project is still worth completing. Government may want to regain control of the project after previous unsuccessful development because a *PPP* contract is usually related to public facilities or services and, therefore, cannot be transferred directly to a new developer without a new contract negotiated and signed with government. In other words, government would consider the bankruptcy a costly replacement of the developer. Suppose that under normal situations, the bankrupted project acquired by government will still be financed mainly by debt, and the subsidies for securing the lending bank's new loan are essential in order to complete the project or continue the operation. As a result, when a project is bankrupted, the amount of budgeting overspending can be modeled as

$$B = G + \tau \tag{10}$$

where G is the least required subsidy that can persuade the lending bank to support a distressed project, and τ is the opportunity cost for replacing developers, 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

$$n(B) = \beta(B) \tag{11}$$

Substitute equation (10) into (11), and then equation (11) can be rewritten as

$$n(G+\tau) = \beta(G+\tau) \tag{12}$$

Figure 6 shows functions $n(G)$ and $n(G+\tau)$, defined by equation (12), where given τ is fixed, the variable of horizontal axis will be G. Thus function $n(G+\tau)$ is depicted differently from $n(G)$, as shown in Fig. 6, by shifting the original $n(G)$ to the left by τ.

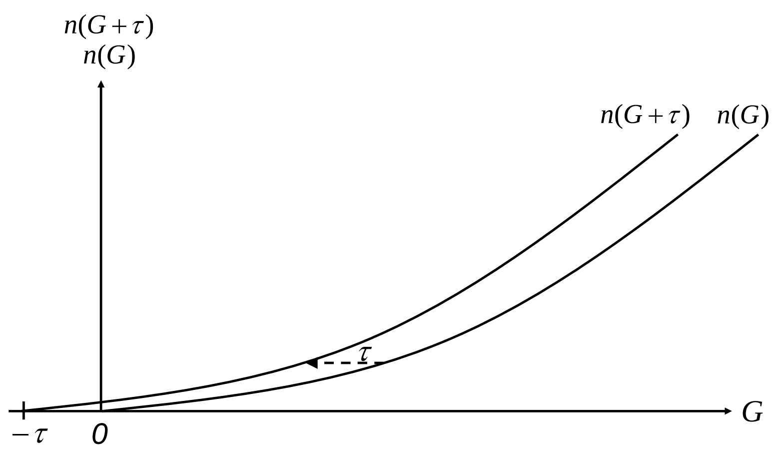

Fig. 6. Function $n(G+\tau)$ w.r.t. to G, given a Fixed τ

- *Mathematical Characteristics of the Parameters in PPPs*

Characteristic 1. As argued previously, by the definition of *G*, if government intends to rescue a project, the subsidy to the project must be at least equal to *G*, i.e., $gU \geq G$.

Characteristic 2. Whereas the developer replacing opportunity cost is always positive and significant, i.e., $\tau >> 0$.

Characteristic 3. Since not all losses due to financial viability change can be justified for subsidy during renegotiation, the range of *J* can be modeled as

$$J \in [0, U] \tag{13}$$

The amount of justifiable subsidy depends on how the public may agree with the subsidy considering the developer's justifiable reasons. Alternatively, *J* may also be quantitatively determined should the subsidy request be brought to court.

Characteristic 4. According to the NPV investment rule, we may define *G* by the equality: $G + NPV_t = 0$, meaning that *G* will revert the project NPV to zero. This characteristic comes from the requirement that *G* should improve a project from negative NPV_t to zero NPV. Note that zero NPV indicates that the project has normal profit and is worth continuing for developers.

4.2.4 Refined Nash Equilibrium

Previous sections conclude that equations (6) and (8) 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

$$m(gU) \leq n(B) \qquad \text{where } gU \geq G \tag{14}$$

Substitute equation (10) into (14), equation (14) can be rewritten as

$$m(gU) \leq n(G + \tau) \qquad \text{where } gU \geq G \tag{15}$$

Since $m(gU)$ is an increasing function, gU must have an upper limit, below which the inequality in equation (15) is satisfied. The upper limit of gU can be obtained by solving $n(G + \tau) - m(gU) = 0$. Thus, the condition for rescue equilibrium can also be reorganized and expressed by the lower and upper limits of the subsidy as shown in equation (16),

$$gU \in \{x : G \leq x \leq m^{-1}[n(G + \tau)]\} \tag{16}$$

where $m^{-1}[n(G+\tau)]$ is the inverse function of *m*. Here equation (16) will be called "Renegotiation offer zone." Figure 7 shows the rescue equilibrium condition, equation (16), and the renegotiation offer zone, indicated by the grey bar in the *x* axis. Given any *G* in Fig. 7, $n(G+\tau)$ 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 equation (15). In other words, the negotiation settlement will fall within the range between *G* and $m^{-1}[n(G+\tau)]$, expressed as [G, $m^{-1}[n(G+\tau)]$].

4.3 Propositions and Rules

4.3.1 Propositions

This section presents propositions implied by the equilibrium of game model. Detailed proofs of the propositions are skipped but can be found in Ho (2006a).

- *Proposition 1:*

Assume that the rescue renegotiation process follows the game tree in Fig. 3, that *g*, *U*, *J*, *G* and τ are non-negative and common knowledge, and that *m* and *n* are non-negative increasing political cost functions and common knowledge. 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, and the renegotiation offer zone is $gU \in \{x : G \leq x \leq m^{-1}[n(G+\tau)]\}$.

For the smoothness of the reading, interested readers please refer to Ho (2006) for the formal proofs of all propositions. Proposition 1 is graphically illustrated in Fig. 7, where the renegotiation offer zone is indicated.

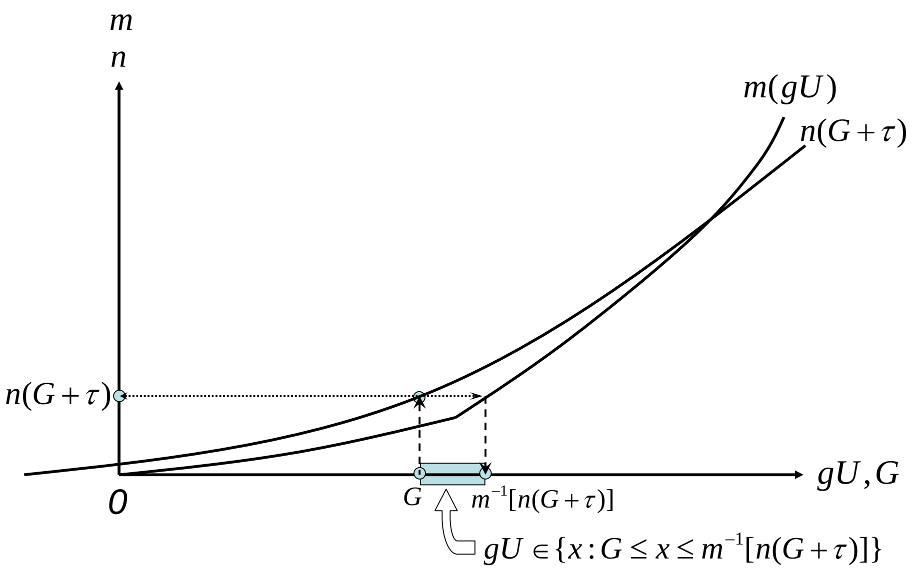

Fig. 7. Renegotiation Offer Zone in "Rescue" Equilibrium

- *Proposition 2:*

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

Note that proposition 2 can be illustrated by Fig. 8.

- *Proposition 3:*

Suppose all assumptions in proposition 1 hold. It must be true that the larger ρ_s function will yield a smaller S_α.

Note that proposition 3 is illustrated by Fig. 9, which shows that the steeper the function *m* is, the smaller the S_α is.

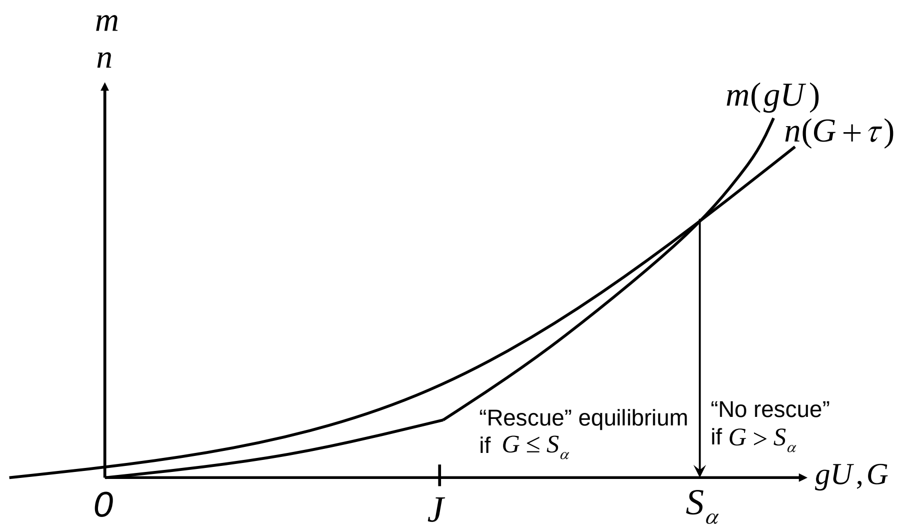

Fig. 8. Illustration of Proposition 2

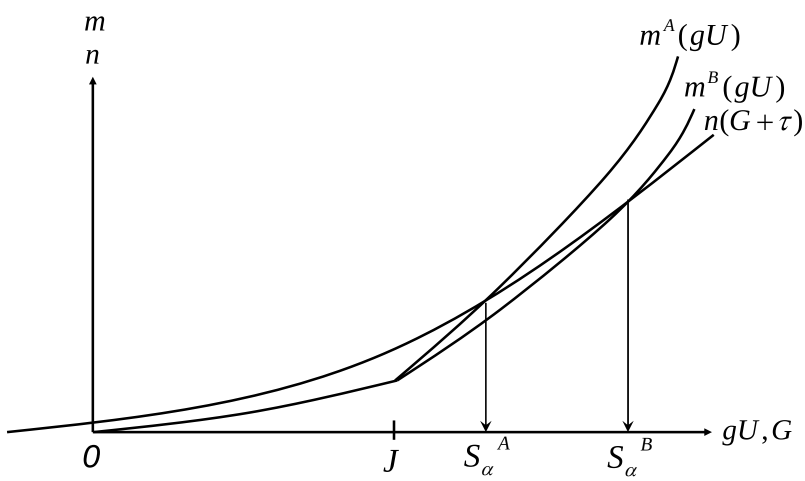

Fig. 9. Illustration of Proposition 3

4.3.2 Rules due to the Propositions

The propositions can be transferred into rules to assist policy makers analyzing various renegotiation situations. The following rules are either from the propositions directly or the logical inference following the propositions. Discussions associated with each rule are given after stating the rule. Rigorous proof of these rules is not difficult to obtain and is left to interested readers due to length limitation.

- *Rule 1: Equilibrium Determination Rule*

  The equilibrium determination point is S_α. The equilibrium is to "rescue" if $G \leq S_\alpha$, and is "no rescue" if $G > S_\alpha$.

- *Rule 2: S_α Determination Rule*

  S_α will depend negatively on ρ_s, and positively on τ and J.

  Remark:

  If ρ_s is small enough to be ignored, then S_α will approach ∞ and the equilibrium will always be to "rescue." A direct inference from this rule is that in a more dictatorial country government will be more inclined to rescue a distressed project, justifiably or not, given that the project is still socially beneficial. Also, given other variables fixed, $\tau = 0$ will yield the smallest S_α, which will be J, and functions $m(x)$ and $n(x)$ will be on the same curve for all $x \leq S_\alpha = J$.

- *Rule 3: Renegotiation Offer Zone Rule*

  If the equilibrium is to "rescue," the renegotiation offer zone will be $gU \in \{x : G \leq x \leq m^{-1}[n(G+\tau)]\}$.

  Remark:

  This solution is considered a Pareto optimal solution for both parties since both parties' payoffs will be improved compared to "no rescue" solution. The difference between $m^{-1}[n(G+\tau)]$ and G is the surplus obtained by reaching the settlement. The remaining question is how this surplus will be divided. The division of the surplus may depend on each party's negotiation power and risk attitude (Binmore, 1992). Detailed discussion is beyond the scope of this chapter.

- *Rule 4: Interval of Renegotiation Offer Zone Rule*

  If the equilibrium is to “rescue,” then the interval of the renegotiation offer zone will depend positively on τ . Particularly, when $\tau = 0$ the interval of the zone will be zero, the rescuing subsidy will reach at $gU=G$.

  Remark:

  Literature has attributed the occurrence of renegotiation to the hold-up problem due to the opportunity cost of contract termination, e.g., in our model, the developer replacing cost, τ . This rule confirms that the larger the replacing cost is, the more serious the hold-up problem is, and as a result, the wider the interval of the renegotiation offer zone is. However, surprisingly, Rule 4 shows that when there is no replacing cost, i.e., $\tau = 0$, the equilibrium still guarantees the occurrence of renegotiation given that the “rescue” condition in Rule 1 is met. The major reason is the existence of the least required retendering subsidy, *G*. Apparently, *G* becomes the new basic factor for the hold-up problem when the project is financed through the *PPP* scheme. By the definition of project distress, *G* must be positive, and therefore, the hold-up problem must exist.

4.4 Governing Principles and Policy Implications for Project Procurement and Management

Governing principles and administration policy implications can be obtained from the propositions, corollaries and rules derived from the model. Note that the proposed model does not provide the approaches to quantifying the game parameters; instead, this pilot study focuses on the characteristics of the game parameters/functions and the relationship between these parameters. Particularly, the political cost functions *m* and *n* may be the most difficult to be quantitatively determined. Such tasks are beyond the scope of our modeling. Fortunately, useful insights can still be drawn without knowing the approaches to quantifying parameters. Our focus will be on what strategies or policies can better handle and reduce the renegotiation problem and enhance the administration in *PPPs*. Suggested governing principles and administration policies for *PPP* projects are given as follows.

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

Practically, S_α will be greater than 0 as S_α cannot be 0 unless J = 0 and τ = 0. Thus, it is always possible that $G \le S_\alpha$ given that G is uncertain; i.e., it is impossible to rule out the "rescue" equilibrium. As a result, the government should be well prepared for the opportunism problems induced by the *ex ante* expectation of renegotiation as discussed previously. Policy implications from this principle include:

- In project procurement, while the developer's financial model is typically included in the proposal for reference, government should recognize the possibility of opportunism problems and always have reasonable doubt on the proposal provided by developer.
- Government could devise a better mechanism that can enable the developer to reveal true information. For example, government can establish a formal procedure that may disqualify a developer during procurement if the developer is determined to have the history of behaving opportunistically.

Governing Principle 2: Although renegotiation is always possible, the probability of reaching "rescue" equilibrium should be minimized and could be reduced by strategies that increase the political cost of oversubsidization, ρ_s *, and reduce the developer replacing cost,* τ *, and the justifiable subsidy, J.*

One way to reduce the opportunism problems is to minimize the probability of "rescue" equilibrium and the developer's expectation of the probability. According to Rule 1, the probability of "rescue" can be reduced by having a smaller S_α, which can be achieved by strategies that increase ρ_s and reduce τ and J. Policy implications by this principle may include the following:

- Specific laws may regulate the renegotiation and 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 impact, 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 process.

Governing Principle 3: During the renegotiation process, the government should try to settle the rescuing subsidy at G, the least required subsidy to retender a project, and spend more efforts on determining G objectively and conveying such information to the developer, rather than on negotiation skills.

Since the "rescue" equilibrium is a dominant or superior solution for project developer, the government should try to settle the negotiation at *G*, the lower bound of the renegotiation offer zone. Policy implications may include:

- Government could regulate the negotiated subsidy by the laws that explicitly forbid a subsidy being greater than *G*. According to this policy, government should spend more efforts on determining *G* objectively and conveying such information to the project developer. For example, *G* can be assessed through the survey toward major bankers in the market on the least required retendering subsidy for a particular project. Therefore, government is suggested to build a objective and transparent standard procedure for determining *G*.

Governing Principle 4: Government should make every effort on having more information for determining a fair justifiable subsidy, J, which corresponds to the developer's responsibilities and allocated risks specified in the contract.

Holliday et al. (1991) 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. The "developer-led" phenomenon implies the information asymmetry problem and opportunism problem in *PPP* projects, where the developer may be more capable of hiding information and may have incentives to behave opportunistically. Another issue is that *J* is fair only when the allocation of risks and responsibilities is appropriate. As Ho and Liu (2004) proved and Rubin et al. (1983) argued, harsh contract will only encourage opportunistic behaviors. When the amount of *J* is brought to court or special committee, the court or committee will consider not only the contract clauses, but also the fairness of the contract. 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 should devote more efforts on appropriate risk allocation in the contract, than on harsh contract clauses.
- Risk assignments between the concessionaire and government should be made explicitly in the agreement. This could help to determine a fair *J* in the future.
- 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 shows certain signs of potential distress according to the monitoring or warning system mentioned above.
  - Whereas one of the major purposes of the government intervention is to improve the project status so as to prevent an actual distress, other major purposes here could be of information concerns. By temporarily taking over a project, government may have more information regarding how poorly the project has become, who should be responsible, how to minimize the impacts of an actual distress, and how much subsidy could be justified. As a result of stepping in, even if eventually the distress is inevitable, government will obtain more objective information regarding *J* and *G*, and will reduce τ due to longer lead time to respond and prepare for the retendering.
  - Nevertheless, government should not intervene too hastily or early, since the risk and responsibility may be partly transferred back to government if the step-in itself cannot be justified.
  - Thus, the step-in decision should be cautiously made not only by government officials, but also by outside experts, following a standard procedure.

4.5 Case Study: Taiwan High Speed Rail

To illustrate the practical implications and applications of this model, here we will study a major *PPP* project in Taiwan. We will also discuss some lessons learned from the perspective of the model in the case study. Taiwan's first law in supporting the partially use of *PPPs* in transportation infrastructures was passed in 1994. As mentioned earlier, later in 2000, Taiwan enacted *The Act for Promotion of Private Participation in Infrastructure Projects* to support the use of *PPPs* in most public infrastructures and services. Up to April 2005, there had been about 280 *PPP* projects funded in Taiwan, with US$ 25 billions or so invested by private parties. The

Taiwan High Speed Rail, one of the largest *PPP* project in the world, and the Taipei 101 building, currently the tallest high rise building in the world, are among the major projects funded under *PPPs*.

4.5.1 Background of Taiwan High Speed Rail

The Taiwan High Speed Rail (THSR) project delivered the first high speed rail system in Taiwan. This project is the largest transportation infrastructure in Taiwan and also one of the largest projects in the world delivered through *PPPs*. This project is developed through the Build-Operate-Transfer (BOT) scheme and within the 35 year concession period the awarded concessionaire must deliver the project in return for the operating profit from the rail system. The high speed rail connects Taiwan's major cities from north end to south end by running trains up to 300 km/hour through the 345 kilometers route.

The procurement of the project officially began in January 1997 and the project was awarded to Taiwan High Speed Rail Corporation (THSRC) in September 1997. After ten months of negotiation, the project concession agreement was signed in July 1998. The full span construction of the high speed rail began in February 2000 and after almost seven years the high speed rail was completed in January 2007, with a 14 months delay. The actual total costs of the project upon completion are about $18.4 billions, including $3.4 billion costs committed by government and $15 billions invested by private parties, taking accounts of $2 billions cost overruns. Major works completed by private investment include civil works, stations, track work, electrical and mechanical system, and financing cost. The items undertaken by government, called "government assisted items," were mostly related to the exercise of government authority, such as land acquisitions and construction supervision.

The capital structure of the THSRC was originally targeted at 30% equity ratio and 70% debt ratio, and was later revised to 25% : 75% equity and debt ratios. While the total amount of equity to be raised is about $4 billions, nine months after the contract was signed, the THSRC was still thinly financed by $0.6 billion of equity. As we will discuss next, the THSRC later on had substantial difficulties in raising the rest of the equity according to the contracted schedule and was forced to renegotiate the total equity amount down to $3.3 billions. In fact, the THSR project encountered various major difficulties during the project construction period, and most of these issues were related to financing. In the following sections, we shall first present the key events in financing and renegotiation issues and then discuss how the renegotiation model may help to understand the development of these events and how the model can help to prevent or alleviate these problems.

4.5.2 The Awarding of THSR Project

- The awarding:

There were only two alliance teams competing for the project, Taiwan High Speed Rail Alliance and China High Speed Rail Alliance, and the project was awarded to the Taiwan High Speed Rail Alliance. Since the technical concerns are limited due to the maturity of high speed rail technology, the competition was focused on the financial issues. In their financial proposal, China High Speed Rail Alliance requested government to invest $4.6 billions, in addition to the government assisted items, to make the project financially viable. On the other hand, Taiwan High Speed Rail Alliance requested zero additional government investment, and further promised that the government may receive at least $3.2 billions royalty-like payback from the project operation revenue by the end of concession period.

- Remarks:

The government made several serious mistakes in the procurement of the THSR project. First and the most critical among all, the government should not adopt *PPPs* in the THSR, a mega project that is not allowed to default, particularly when the government had no experiences in *PPPs*. According to the renegotiation model, the opportunism is most serious when the government cannot allow the project to fail or when the political cost of project failure is too high to bear because under such condition it is almost surely that the government will bail out the project at any cost. As a result of opportunism, it is highly possible that the developer's financial proposal will be overly optimistic. In fact, after the awarding decision, the government was criticized of naively believing in the winner's financial proposal. Nevertheless, we should also recognize the difficulty to differentiate whether the financial forecast is fair or too optimistic, particularly in *PPPs*, where creativeness and efficiency from private parties are emphasized. According to the model, the government should focus on eliminating the sources of opportunism, for example, the expectation of government's rescue.

It is worth noting that current practice in *PPPs* that involve construction inherently creates incentives for developers to behave opportunistically. For example, in the THSR, two of the major promoting firms were construction firms and the construction contracts of the project undertaken by the two firms amounted to $3.3 billions or so while the total equity invested by the two firms was only $0.36 billion. This type of stakeholder and profit structures would make the promoters emphasize greatly the short term construction profit, instead of long-term operational profit. Given the existence of such incentives to behave opportunistically, the importance of reducing the possibilities for opportunism cannot be overstated.

4.5.3 The Debt Financing Crisis

- The crisis:

The first crisis faced by the THSRC is the inability to obtain the debt financing of $10 billions after signing the concession contracts. In this project, the developer did not utilize the international debt markets for financing partly because Taiwan government was expected to subsidize the loan interest by a rate far below the market. However, since the THSR was the first *PPP* mega project in Taiwan, the banks had no faith in financing the project at a below market fair rate without government’s “full” debt guarantees. Since the full debt guarantee was a significant contingent liability to government and was neither anticipated by government nor specified during the procurement process, the provision of debt guarantees became a controversial issue that caused many serious criticisms. Due to the hesitation of government in offering debt guarantee, the THSRC failed to obtain the debt financing as proposed in the financial proposal. The financial viability of the project might become unacceptable if a fair market interest rate was imposed. At last, the THSRC gave government an ultimatum that if government did not help to settle the debt financing negotiation by July 31st 1999, the THSRC would abandon the project. In response to the ultimatum, the government offered full debt guarantees and signed a debt financing agreement in August 1999 with syndicate banks and the THSRC. Moreover, among the $10 billions of debt financing, $8.6 billions came from government owned banking systems and only $1.4 billions belonged to private commercial banks. Note that in this event the Prime Minister Mr. Hsiao explicitly expressed his attitude toward the project that “the project is not allowed to fail” and “government will do everything to support the project.”

- Remarks:

The negotiation in this crisis can be considered the first financial renegotiation in the project. From the perspective of the introduced model, the political cost of not rescuing the project was the political cost of spending three more years and the procurement cost to replace the developer. On the other hand, the political cost of rescuing the project was relatively low. First, the rescue could be easily rationalized by government's role in facilitating the transactions between the developer and the banks given that it was difficult for most people to know how large the liability was to offer the debt guarantee. Second, the government resorted to the importance of the project. This justification can be seen from the statements made by the Prime Minister Hsiao mentioned above. The tragedy is that the attitude that "the project is not allowed to fail" gave the developer even more advantages and opportunities to renegotiate later in the equity raising during the construction stage.

4.5.4 The Equity Raising Crisis

- The crisis:

According to the concession contract, the total amount of equity to be raised is $4 billions and the time table for equity raising is specified in the debt financing contract. The fulfillment of the time table is a prerequisite for withdrawing funds from the loan credit facility. The THSR was still thinly financed by $0.6 billions equity in September 1999, nine months after signing the concession contract. For the next seven years before project completion, the THSR constantly had difficulties fulfilling the equity raising requirement. The inability to raise sufficient equity had caused the crisis of the THSRC's breach of the concession contract. Two major reasons contributed to the equity raising crisis. First, at the time of initial equity raising stage around 1998 to 1999, Taiwan's economy was still in the after shock of the 1997 East Asian financial crisis and the climate for taking risk in investing the unfamiliar high speed rail was very conservative. Second, the market had substantial doubt on the project profitability, whereas the THSRC's financial proposal was too optimistic, with too much equity left to be raised. Note that lower initial equity will have higher return from following equity raising if the project is expected to be successful at the time of raising. However, if there is substantial doubt on the project profitability, the lower offering price in equity raising will hurt the initial equity's profitability. The doubt on the project profitability could be seen from the initial shareholders' reluctance of investing more equity later on although they had the capacity to make further investment. As a result, a couple rounds of renegotiation between the THSRC and banks took place and finally the banks could only accept the THSRC's proposal to reduce the total equity amount to $3.3 billions.

The Taiwan government played a crucial role in bailing out the THSRC from the equity raising crisis. The government was criticized of having the government owned/controlled enterprises (GOEs) or non-profit organizations make substantial equity investment in the THSRC, although the government argued that the government controlled enterprises/organizations should not be counted as GOEs. For example, the last equity investment of $0.23 billions by the government controlled non-profit organizations in September 2005 caused one of the most serious criticism for government's unjustifiable aids and failure in monitoring the project. During this equity raising crisis, the government announced again that "government is determined to ensure the completion of the high speed rail." However, the soaring criticism and associated political costs toward the government investment forced the Prime Minister Mr. Hsieh to publicly assure that "government will make no further equity investment in the THSRC because it is against the will of the society and people." In fact, the government's "September 2005 equity investment" was later determined by the court that it is illegal for this non-profit organization to make the equity investment. Up to date, the total equity of the THSRC is close to the revised target, $3.3 billions, where common stocks and preferred stocks are about 49% and 51% of total equity, respectively. We also find that total passive equity investment by GOEs and government owned banks is about 23% of total equity, or 35% of total equity if considering investments from some government controlled non-profit organizations, while initial equity invested by the promoters is only about 28.5% of total shares.

- Remarks:

Unlike the debt guarantee for debt financing, the equity investment is an asset, instead of liability. Therefore, the political cost of having GOEs make several rounds of equity investment in the early construction stage was relatively low and the government would choose continuing to help the THSRC. However, the equity investments in late construction stage caused more and more criticisms since the failure to raise equity when project was near completion signified pessimistic profitability expectation and thus the equity investments were seen by public as government subsidy. From the perspective of renegotiation model, the political shock due to "September

2005 equity investment" could be considered the result of the sharp political cost increase when the subsidy passed the "justifiable" amount even though the "September 2005 equity investment" amount was not particularly large.

4.5.5 The Cost Overrun Crisis

Around one year before the project completion, only three months after the government's "September 2005 equity investment," the THSRC announced that the total cost overrun was estimated to be $2 billion or so due to the estimated one year schedule delay and construction cost overrun. Due to the serious political impact of previous unjustifiable government investment, the government had ruled out the possibility of providing any equity investment or liability guarantees. To a degree, the government for the first time formally announced that the government would make plans to takeover the project if the THSRC could not raise either equity or debt to finance the additional capital needs. Since it had been almost impossible for the THSRC to raise any further equity, the THSRC decided to supplement the capital gap through debt financing. Nevertheless, it was also a daunting task for the THSRC to obtain another $2 billions debt at this stage, mainly due to that the debt ratio had just passed over the revised 75% at that time and that the market had further doubts on the project financial viability because of the cost overruns.

The THSRC finally obtained a $1.4 billion debt financing by arranging a "second mortgage financing" type loan, in which the THSRC used the concession rights on project associated real estate development as the collateral for the loan. This arrangement again brought criticism against government. Since all the physical assets obtained due to the project had been assigned as collateral during previous debt financing, the rights on project associated real estate development cannot independently exist if the THSRC defaults. Therefore, it did not make too much sense to use the development rights as collateral. Moreover, in this arrangement the government had to officially agree upon the collateral to be assigned to the banks. The government was blamed to agree upon the collateral assignment and to urge the leading syndicate bank to accept such deal. Nevertheless, the criticism is not as harsh as that from the previous equity investment.

- Remarks:

The cost overrun crisis almost became the last straw that broke the camel's back and made the government prepare for the possible taking over of the project. From the perspective of the renegotiation model, any significant subsidy after the "September 2005 equity investment" would renter the political cost of rescue larger than that of taking over the project. Note that although the cost of taking over and retendering the project was supposed to be substantially large in the stage of near completion, the even higher political cost of providing more subsidies showed that how sharp the slope of the political cost of unjustifiable subsidy as shown in Fig. 5 could be.

4.5.6 Lessons Learned: the Perspectives of the Financial Renegotiation Model

- Do not have a project that is not allowed to default:

Projects that are too important to fail or too expensive to default for the society are not good candidates for *PPPs*. Such projects will create more opportunities of opportunism than others. Unfortunately, the THSR project was too important and too expensive to default.

- Do not focus too much on the bidder's financial proposal:

Due to opportunism rationality, the more incentives and opportunities for opportunism are, the lower the credibility of the bidder's financial proposal is. Therefore, more optimistic proposal requires more justifications for the positive figures. In the THSR project, we did not see the government asking for the justification of the attractive proposals.

- Do not adopt *PPPs* too abruptly when government has limited experiences and incomplete supporting systems:

Incomplete supporting systems and the lack of experiences are also the sources for opportunism opportunities. Government should limit the scope of using *PPPs* at the beginning of introducing *PPPs*. Since the enacting of Tawain's *PPP* law in 2000, the Taiwan government has been very aggressively promoting the use of *PPPs* for almost all possible public infrastructure projects. As a result, we observed many opportunism related problems in many projects.

- Do not force local governments to use *PPPs*:

The Taiwan government had set a yearly goal of signing $3.1 billions of *PPP* projects for the promoting federal agency, the Public Construction Commission. This yearly goal was then passed and allocated to local governments as an important criterion of local government performance. Under such pressure, the local government would use *PPPs* on projects that *PPPs* were not the best choice and that government would become very soft on contract negotiation.

- Do consider to separate the developer and contractors as much as possible:

Although it is not always possible, the government should encourage the separation of the developer and contractors in the procurement process by, for example, giving such separation higher scores in bid evaluation. The separation of the developer and contractors will make the developer emphasize on long term profits and reduce the incentives for opportunism.

- Do prepare in advance for project default:

Well preparing for project default and taking over in advance will reduce the cost of project retendering and hence the renegotiation expectation and opportunism. In the THSR project, when government announced the intention of taking over the project if the THSRC could not obtain the financing for cost overruns, the THSRC did not even try to renegotiate for help.

- Do use professional helps:

Professional helps from acclaimed consulting firms in evaluating financial proposals and negotiating contract terms will largely reduce the intention of behaving opportunistically and the possibility of awarding projects to opportunistic bidders.

- Do know that the transaction costs of *PPP* projects are much higher than that of government projects:

The higher transaction costs for *PPP* projects include more complex project procurement, higher capital costs calculated by fair market returns of equity and debt, and the cost of project administration particularly when renegotiation is involved. Therefore, the lack of government funding should not be the major reason for adopting *PPPs*. The use of *PPPs* for a project should be justified by higher creativeness and efficiency due to private participation. For example, in UK the use of *PPPs* for a project is required to meet the Value for Money criteria. Blindly promoting *PPPs* only because of the lack of government funding will generate more problems and difficulties in the future.

5. Conclusions

The opportunity costs of solving problems due to inferior project concept development or financial renegotiation in *PPPs* are enormous. If these problems take place persistently, the subsequent high transaction costs will make *PPPs* an infeasible or inferior alternative for providing public infrastructures and services. The best and clever way to solve a problem is always to solve the problem before it happens. The purpose of this chapter is to introduce two models as the theoretical foundations for *PPP* policies on two important financial issues: bid compensation and financial renegotiation. Good policies help to prevent problems before they happen. In the bid compensation model, we investigate how bidders react to bid compensation and the policy implications on bid compensation. In the financial renegotiation model, we model renegotiation dynamics and then derive policy implications for discouraging opportunistic behaviors in *PPPs*.

We see that there is a paradox in the bid compensation problem. On one hand, the model solves the equilibrium conditions for effective bid compensation. On the other hand, through the practical implications of these conditions, it is shown that the offering of bid compensation is not recommended in most cases. The ineffectiveness of bid compensation was also partially confirmed in a discussion paper by a very experienced practitioner. We conclude that to discover creative approaches to stimulating quality inputs from bidders are desirable in *PPPs*.

From the financial renegotiation model, governing principles and policies for *PPP* administration are inferred. These policy implications cover issues in project procurement and management, in addition to renegotiation itself. Note that although the advance in public project procurement practice has reduced the opportunities for opportunism, opportunism never cease to exist in the mind of every rational and economic individual. As we have observed in many projects, the exploitation of renegotiation possibility in a complex contract or *PPPs* is a typical behavior of opportunism that poses many serious problems. The model is expected to help government authorities and policy makers establish more effective polices for *PPP* projects. The case study of the Taiwan High Speed rail project shows how the renegotiation model can help to prevent or alleviate the opportunism problems. Four do's and four don'ts lessons learned from the perspective of the model as well as the experiences of Taiwan's *PPPs* are discussed.

Note that, as in many economics studies, some simplified assumptions are made in these models so that useful insights can be drawn from real life complex situations. These insights could provide decision makers with useful concepts and directional principles, despite that the real situation is more complex. The insights and qualitative implications of an economic model are often more important than the exact solutions obtained in the model. Furthermore, the two models can consider various project environments characterized by the parameters of the model. Also note that the validity of this model does not require government and the developer to explicitly "use" game theory; instead, the only requirement is that all players are rational decision makers.

Lastly, although in practice there are many guidelines for various *PPP* schemes in countries such as UK, these guidelines cannot be universal to every country in the world. Guidelines and policies need to be reexamined to fit the specific environment of a country according to certain logic. The models in this chapter may help to provide such logic for understanding problems and make appropriate modifications. Rigorous theories concerning government policy in *PPPs* are difficult to find. The pilot studies introduced in this chapter, the author hopes, may provide a theoretic foundation and analytic logic for making effective *PPP* administration policies and respective guidelines for different governments.

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