

Original Research Article

The Analysis of Regulatory Strategy about Government-Invested Projects Based on the Imperfect Credibility Threats

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Abstract: In the construction market, it is very difficult to obtain the private information of project management units which have uneven aptitude for the government. In order to reduce the government's risk caused by adverse selection in bidding, cut the loss because of the violations of the agent in the process of project construction, and prevent the decision failure because of the malfeasance of supervision department in government regulation, this paper carries on the game analysis through establishing an including uncertainty complete and imperfect information dynamic model, and analyzes the critical factors which have an great effect on the agent market. The result shows that the government should regulate the supervision policy of agent construction system from the aspects of developing the credibility of threat, decreasing the implementation cost of advanced technology and management experience, reducing the expect to agent construction project about unqualified project management units, and government self-improvement.

Keywords: Agent construction system; Government regulation; Imperfect information; Imperfect believable threat.

INTRODUCTION

Agent construction system (ACS) refers to the project management mode where the government selects the specialized project management units (namely the agencies) through public bidding to construct and manage the project, and then delivers to the use units after the completion of the project. ACS has been carried out for more than ten years in China since the state council issued "Decision on reform of investment system" in 2004. Although professional management and marketization operation can effectively improve the quality of engineering, reduce the engineering cost and ensure due completion, the government fails to gain the information of management units themselves who are uneven about their qualifications. Therefore, the unqualified bidders may successfully win the bid through passing favorable information to the government. The government may suffer from the risk caused by the adverse selection problem. Moreover, the agency may break the rule or slack off for greater benefits. The government may bear the huge loss and damage due to the asymmetry of information accordingly. To avoid the risk caused by asymmetric information, the key is to design a set of optimal contract or mechanism to promote the agencies to reveal their information consciously.

Many experts and scholars have analyzed regulation strategies of government-invested agent projects (GIAPs) and put forward their own views. Literature [1] considers that the government auditing supervision department has the responsibility and obligation to conduct the comprehensive audit supervision on the GIAPs and puts forward some specific suggestions on how to train the audit professional personnel and gradually implement the auditing results announcement system on GIAPs. The service reward of ACS is analyzed [2]. Based on that, the rationality and feasibility of the charging model have been demonstrated. Then the charging model is improved on the basis of the principal-agent theory [3, 4], which has been proved to increase the incentive effect and the benefit of all parties concerned. Game matrix is constructed to analyze the bidding process and benefits, and the corresponding regulatory strategies for avoiding the risk caused by the adverse selection problem have been presented [5]. Moreover, game model has been built to analyze the repeated regulation violence of the agencies [6]. Based on the game results, the reasons for that are founded: lagging government regulation, the lack of effective incentive and credit system of agent market. The above studies are important to develop and perfect the supervision system of China's GIAPs. However, there are also several

problems existing by now, such as (1) failing to consider the inadequacies and asymmetry of information between the government and the agencies, which may increase a lot of difficulties to post-supervision; (2) failing to consider the collusion and corruption caused by the unqualified units when increasing the incentive effect on the agency; (3) The uncertainty of review results from the government regulators may lead to different decisions, which will have a great influence on the effectiveness of the parties.

Aiming at the shortcomings of the above research, this paper further analyzes the regulation strategies on GIAPs. Firstly, the practical problems are abstracted to set up uncertain completion but not perfect information dynamic game models between construction unit with all kinds of qualification and the governments. Next, the paper solves the game model and analyzes the conditions needed for all kinds of perfect Bayesian equilibriums. Meanwhile, according to various conditions, this paper finds out the key factors influencing the agent market. Finally, this paper proposes the effective strategies for standardizing GIAPs, which contributes to reducing the information asymmetry of the game parties. Through the above efforts, the positive competition mechanism will be formed and the great damages the violations bring to people's lives and properties can be effectively avoided.

DYNAMIC GAME MODEL FOR GIAPS

During the construction of agents, the agency instead of the government manage the entire project in accordance with the requirements, and then delivers the engineering products meeting the requirements to the government. Unfortunately, the government cannot supervise the whole activities of the agency in real time and just can estimate according to the partial information and the construction of output, due to the information asymmetries. In the process of bidding, the agencies can tender with a price lower than the government budget relying on the advantage of the advanced management technology and rich experience. Also, these units can reduce the budget target by the collusion with other contractors or other violations, without any effort and cost. However, some units with poor qualification will also participate in the bid to survive in the market. In order to compete with the qualified enterprises, the units with poor qualification have to tender with a price lower than the government budget. In this way, the units with poor qualification have to obtain profits through illegal means.

From the perspective of game theory, in the supervision process of GIAPs, the agency has two optional strategies: bidding and not bidding. If the

agency bids, two strategies, namely irregularity and observation, can be used to manage projects during the construction. Observation means no risk and the participation units need put more efforts. Compared with observation, irregularity can achieve the same goal with less effort yet more risks of punishing by the government. For the enterprises with advanced technology and management experience, participating in the bidding is the strictly best choice, and the optional strategies are irregularity and observation. For the poor enterprises, since they cannot achieve the final goal without irregularities, bidding must be not a good choice. Thus, their optional strategies are participating in the bidding and implementing irregularities and giving up bidding respectively.

Meanwhile, the government also has two strategies to choose, namely stringent regulation and lax regulation. In order to simplify the model, this paper supposes that stringent regulation can certainly find the irregularities, and lax regulation may or not find the violations with some uncertainties. Since the behaviors of the players are in the sequential presentation, the government cannot figure out the preceding party's behavior. Also the game parties can completely know the benefits each other at the end of game. Thus, a complete and imperfect information dynamic model with uncertainty can be built. There are seven model assumptions listed as follows.

Assumption 1. The agency in the market can be divided into two kinds: one is the "good" (g) agency who has the advantage of the advanced management technology and rich experience. And the other one is the "bad" (b) agency who cannot achieve the final goal without irregularities. The proportions of " g " and " p " are x and $1-x$ respectively.

Assumption 2. In order to save ΔI , " g " needs cost C_1 with observation and C_2 with irregularity ($C_1 > C_2$). For " g ", the probability of observation is p , and the probability of irregularity is $1-p$. For " b ", the probability of observation is t , and the probability of irregularity is $1-t$.

Assumption 3. For the government, the probability of stringent regulation is q , and the probability of lax regulation is $1-q$. Stringent regulation can certainly find the irregularities, and lax regulation can find the violations with the probability r . However, stringent regulation needs more manpower material resources to identify information and overcome the additional resistance etc., the corresponding cost is $C + \Delta C$, with C being the cost of lax regulation.

Assumption 4. Participation units can gain the basic service fee F ($F > C_2$). If the regulation result from the government is “observation”, participation units receive a reward $\delta\Delta$. δ is the incentive coefficient. On the contrary, participation units receive a penalty $\mu\Delta$. μ is the penalty coefficient.

Assumption 5. The penalty upon participation units should revert to the government. The benefit of the government increases $\mu\Delta$.

Assumption 6. The basic benefit of the government is R . The loss caused by the irregularities of participation units is $n\Delta$ ($n > 1$).

Assumption 7. $\delta, \mu, n, C_1, C_2, C, \Delta C$ and so on are open information.

Based on the above model assumptions, a complete and imperfect information dynamic model can be constructed as follows. Firstly, the agency “g” or “b” will be selected. For “g”, two strategies are optional: participating with irregularity and observation. For “b”, two strategies are optional: participating with irregularity and giving up participating. The above information is unknown for the government before regulation and the participation units also do not know the regulation strategy. Next, the government selects a regulation strategy. Then, if the government implements lax regulation, the probability of rule violation detection is r (if existing). Finally, the model is shown in Figure 1. To eliminate the uncertainty, this paper supposes that both players in the game are risk-neutral. The complete and imperfect information dynamic model for GIAPs is shown in Figure 2.

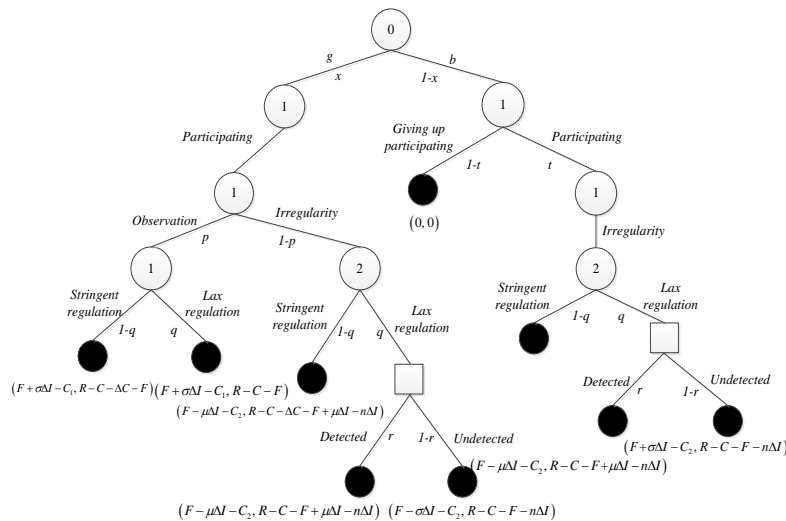


Fig-1: The complete and imperfect information dynamic model with uncertainty for GIAPs

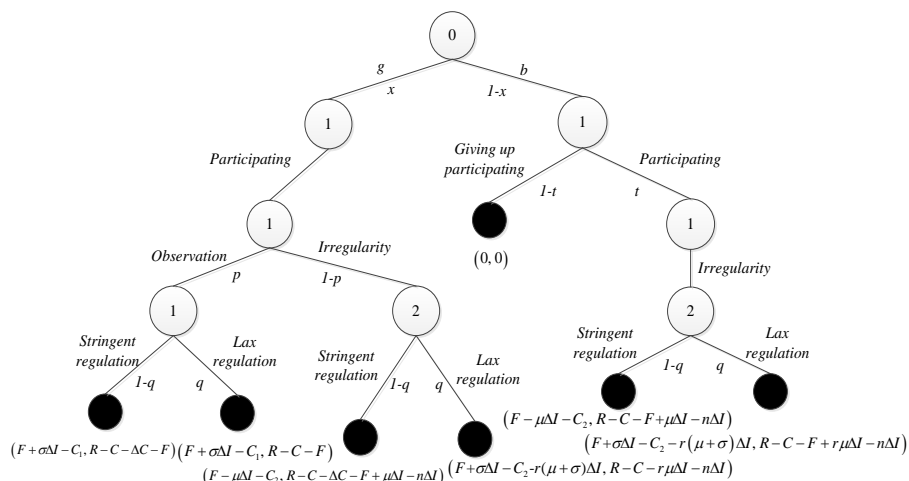


Fig-2: The complete and imperfect information dynamic model for GIAPs

THE SOLUTION AND ANALYSIS OF DYNAMIC GAME MODEL ON GIAPS REGULATION

Because of information asymmetry, the government does not know the real qualification of the agencies and their any irregularities. And under certain conditions, both sides have no the best strategy. $0 < x, t, p, q < 1$.

The benefit of “g” without irregularities is:

$$Eu_{11} = F + \delta\Delta I - C_1 \tag{1}$$

The benefit of “g” with irregularities is:

$$\begin{aligned} Eu_{12} &= q[F + \delta\Delta I - C_2 - r(\mu + \delta)\Delta I] \\ &\quad + (1-q)(F - \mu\Delta I - C_2) \\ &= F - C_2 + q(\mu\Delta I - r\mu\Delta I - r\delta\Delta I + \delta\Delta I) - \mu\Delta I \end{aligned} \tag{2}$$

If $Eu_{11} > Eu_{12}$, “g” will not select irregularities.

The probability q will meet the following requirement

$$q < \frac{1 + \frac{C_2 - C_1}{(\mu + \delta)\Delta I}}{1 - r} \tag{3}$$

The benefit of “b” with giving up participating is:

$$Eu_{21} = 0 \tag{4}$$

The benefit of “b” with irregularities is

$$\begin{aligned} Eu_{22} &= F - C_2 \\ &\quad + q(\mu\Delta I - r\mu\Delta I - r\delta\Delta I + \delta\Delta I) - \mu\Delta I \end{aligned} \tag{5}$$

To avoid “b” to participate, namely $Eu_{22} < 0$, the probability q should meet the following requirement:

$$q < \frac{\mu + \frac{C_2 - F}{\Delta I}}{(1 - r)(\mu + \delta)} \tag{6}$$

Likewise, the benefit of the government with stringent regulation is:

$$\begin{aligned} Eu_{31} &= x[p(R - C - \Delta C - F) \\ &\quad + (1 - p)(R - C - \Delta C - F + \mu\Delta I - n\Delta I)] \\ &\quad + (1 - x)t(R - C - \Delta C - F + \mu\Delta I - n\Delta I) \\ &= (x + t - tx)(R - C - \Delta C - F + \mu\Delta I - n\Delta I) \\ &\quad + xp(n - \mu)\Delta I \end{aligned} \tag{7}$$

The benefit of the government with lax regulation is:

$$\begin{aligned} Eu_{32} &= x[p(R - C - F) \\ &\quad + (1 - p)(R - C - F + r\mu\Delta I - n\Delta I)] \\ &\quad + (1 - x)t(R - C - F + r\mu\Delta I - n\Delta I) \\ &= (x + t - tx)(R - C - F + r\mu\Delta I - n\Delta I) \\ &\quad + xp(n - r\mu)\Delta I \end{aligned} \tag{8}$$

Therefore, when the government selects lax regulation, namely $Eu_{32} > Eu_{31}$, the probability q should meet the following requirement:

$$\alpha = 1 - p + 1 - t + \frac{t}{x} < \frac{\Delta C}{(1 - r)\mu\Delta I} \tag{9}$$

The paper assumes that α is the government's judgment coefficient. It is affected by three parameters, namely t, p, x . A smaller α means the government will be more likely to choose lax regulation.

The derivative of α with respect to t is:

$$\frac{\partial \alpha}{\partial t} = \frac{1}{x} - 1 > 0 \tag{10}$$

Thus, the more “g” the government believes in the market, the smaller α will be and the more likely lax regulation will be selected. The more likely the agencies select observation, the smaller α will be and the more likely lax regulation will be selected by the government. The more likely “b” participants, the larger α will be and the more likely stringent regulation will be selected by the government.

Perfect Bayesian equilibrium of pure strategies

(1) If the government considers that there are more “g” in the market who will break the rule with lower probability and “b” will not participant, the government will select lax regulation, namely $q = 1$. α will meet the following requirement:

$$\alpha < \frac{\Delta C}{(1 - r)\mu\Delta I} \tag{11}$$

The agencies know the government's judgment and decision making. That is, they know the government selects lax regulation. The condition for a pure strategy perfect Bayesian equilibrium is that “g” selects observation and “b” gives up participating, namely

$$\left\{ \begin{aligned} \frac{1 + \frac{C_2 - C_1}{(\mu + \delta)\Delta I}}{1 - r} > 1 \\ \frac{\mu + \frac{C_2 - F}{\Delta I}}{(1 - r)(\mu + \delta)} > 1 \end{aligned} \right\} \Rightarrow \left\{ \begin{aligned} \frac{C_1 - C_2}{\Delta I} < (\mu + \delta)r \\ \frac{F - C_2}{\Delta I} < r\mu - (1 - r)\delta \end{aligned} \right. \tag{12}$$

(2) If the government considers that the numbers of “g” and “b” are almost same and they often select irregularities, the government will select stringent regulation, namely $q = 1$. α will meet the following requirement:

$$\alpha > \frac{\Delta C}{(1 - r)\mu\Delta I} \tag{13}$$

Also, the condition for a pure strategy perfect Bayesian equilibrium is that “g” selects irregularities and “b” will participate, namely

$$\begin{cases} 1 + \frac{C_2 - C_1}{(\mu + \delta)\Delta I} < 0 \\ \frac{\mu + \frac{C_2 - F}{\Delta I}}{(1-r)(\mu + \delta)} < 0 \end{cases} \Rightarrow \begin{cases} \frac{C_1 - C_2}{\Delta I} > \mu + \delta \\ \frac{F - C_2}{\Delta I} > \mu \end{cases} \quad (14)$$

Perfect Bayesian equilibrium of mixed strategies

If α meets the following requirement:

$$\alpha = \frac{\Delta C}{(1-r)\mu\Delta I} \quad (15)$$

The government will select mixed strategies: lax regulation with q and stringent regulation with $1-q$.

(1) If q meets the following requirement:

$$\begin{cases} q < \frac{1 + \frac{C_2 - C_1}{(\mu + \delta)\Delta I}}{1-r} \\ q < \frac{\mu + \frac{C_2 - F}{\Delta I}}{(1-r)(\mu + \delta)} \end{cases} \quad (16)$$

At the moment, “g” will selects observation and “b” will give up participating. GIAPs will realize the biggest economic benefits, and the market is completely successful.

(2) If q meets the following requirement:

$$\begin{cases} q < \frac{1 + \frac{C_2 - C_1}{(\mu + \delta)\Delta I}}{1-r} \\ q > \frac{\mu + \frac{C_2 - F}{\Delta I}}{(1-r)(\mu + \delta)} \end{cases} \quad (17)$$

At the moment, “g” will selects observation and “b” will participate and select irregularities. GIAPs will realize the potential economic benefits. Meanwhile, some GIAPs may suffer great damage with the market being partially successful, and the case needs meet the following requirement:

$$\frac{1 + \frac{C_2 - C_1}{(\mu + \delta)\Delta I}}{1-r} > \frac{\mu + \frac{C_2 - F}{\Delta I}}{(1-r)(\mu + \delta)} \quad (18)$$

$$\Rightarrow F + \delta\Delta I - C_1 > 0$$

(3) If q meets the following requirement:

$$\begin{cases} q > \frac{1 + \frac{C_2 - C_1}{(\mu + \delta)\Delta I}}{1-r} \\ q < \frac{\mu + \frac{C_2 - F}{\Delta I}}{(1-r)(\mu + \delta)} \end{cases} \quad (19)$$

At the moment, “g” will selects irregularities and “b” will give up participating. GIAPs will suffer great damage. The situation can phase out “b” with the market close to failure, and the case needs meet the following requirement:

$$\frac{1 + \frac{C_2 - C_1}{(\mu + \delta)\Delta I}}{1-r} < \frac{\mu + \frac{C_2 - F}{\Delta I}}{(1-r)(\mu + \delta)} \quad (20)$$

$$\Rightarrow F + \delta\Delta I - C_1 < 0$$

(4) If q meets the following requirement:

$$\begin{cases} q > \frac{1 + \frac{C_2 - C_1}{(\mu + \delta)\Delta I}}{1-r} \\ q > \frac{\mu + \frac{C_2 - F}{\Delta I}}{(1-r)(\mu + \delta)} \end{cases} \quad (21)$$

At the moment, “g” will selects irregularities and “b” will participate. GIAPs will suffer great damage. In the situation, the market fails completely.

Based on the above analysis, we can get the following conclusions:

(1) For the government, when $\Delta C / [(1-r)\mu\Delta I]$ is larger, the condition for selecting stringent regulation is harder to achieve. Actually, the agencies know that situation. In order to make the government’s regulation a believable threat, $\Delta C / [(1-r)\mu\Delta I]$ should be decreased, namely the additional cost ΔC should be reduced as much as it could be.

(2) According to the formulas (12) and (14), in order to make “g” voluntarily choose observation and “b” voluntarily give up participating, $(C_1 - C_2) / \Delta I$ and $(F - C_2) / \Delta I$ should be reduced as much as it could be. The variables controlled directly or indirectly by the government are C_1 and F . Therefore, the basic service charge of the agencies F and the cost of implementing the advanced technology and management by the agencies C_1 should be reduced as much as possible.

(3) Known from the above analysis, the two most important parameters affecting every player’s decision are incentive coefficient δ and penalty coefficient μ . In order to show the correlational relationship between μ and the condition for the participation of the agencies, this paper supposes:

$$\beta = \frac{\mu + \frac{C_2 - F}{\Delta I}}{(1-r)(\mu + \delta)} \quad (22)$$

The derivative with respect to β is

$$\frac{\partial \beta}{\partial \mu} = \frac{F + \delta \Delta I - C_2}{(1-r)(\mu + \delta)^2 \Delta I} > 0 \quad (23)$$

where $F + \delta \Delta I - C_2 > 0$, $0 < r < 1$.

Therefore, for all the agencies, larger penalty coefficient μ will help to restrain their illegal behaviors. For “g”, larger incentive coefficient δ contributes to

reducing illegal behaviors. However, for “b”, larger incentive coefficient δ will promote implementing illegal behaviors. The tendency chart of the probability p of “g” (observation) and the probability $1-t$ of “b” (giving up participating) with δ changing is shown in Figure 3.

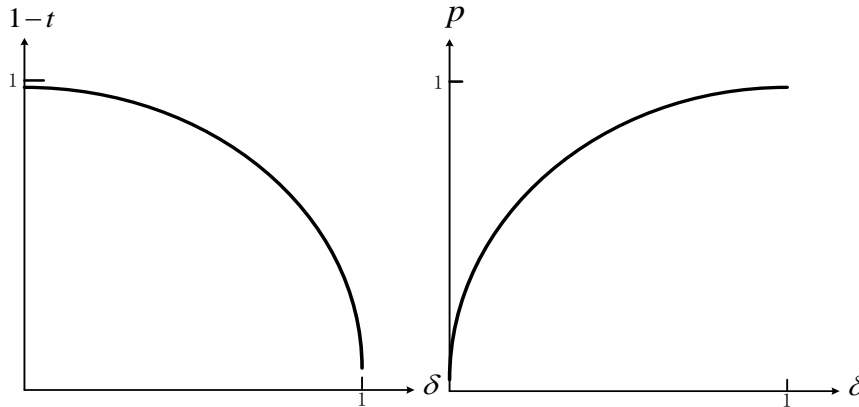


Fig-3: The tendency chart with δ changing

Actually, if the parties are risk-averse rational-economic men, the illegal profit of the agencies should add a negative risk premium due to the risk of punishment. Therefore, “g” will be more inclined to observation, and “b” will be more likely to give up participating. For the government, the expecting profit of lax regulation should add a negative risk premium due to the uncertainty of its results. Thus, the government will be more inclined to stringent regulation. However, according to the incentive paradox, unless both players’ risk degree and the loss caused by the negative risk premium are large enough, the equilibrium can only reach with a lower probability level. Meanwhile, the participation with irregularities and lax regulation with dereliction cannot be avoided completely [7].

COUNTERMEASURES DISCUSSION BASED UPON EQUILIBRIUM MODEL ANALYSIS

The model provides a new method for the construction and improvement of GIAPs regulatory system. Under asymmetric information, the specific ways for ①reducing the probability of participating with irregularities, ② increasing the probability of legal stringent regulation, ③ improving the believable threat of the governmental stringent regulation and ④ stimulating “g” to manage projects with advanced technology and management experience are listed as follows:

(1) Reducing the additional cost ΔC caused by legal stringent regulation.

Firstly, a mechanism with full information exchange and disclosure needs be established, which can decrease governmental information identifying cost through reducing the degree of information asymmetry and weakening the information superiority of the agencies. Secondly, the resistance and friction that the government faces during stringent regulation must be reduced, which will contribute to a lower regulation cost and difficulty. Thirdly, the market access system of the agencies should be standardized and the benign competition market should be established, which will create a good institutional environment for the performance of obligations, reduce the human cost, time cost and opportunity cost.

(2) Reducing the cost C_1 caused by implementing advanced technology and management.

Actually, “g” completely has the ability to achieve cost reduction target in the case of no irregularities. The reason for risking irregularities is the higher cost caused by implementing advanced technology and management. Thus, on the basis of “g” own efforts, the government should also motivate the implementation of advanced technology and management, such as subsidizing the purchase of advanced equipment and technology, supporting company for the cultivation of talents, etc.

(3) Adjusting the pay structure of the participants.

Known from the above analysis, reducing F will eliminate “ b ” to help the formation of benign competition market. Meanwhile, bigger δ is helpful to reduce the violations for “ g ” yet increase the violations for “ b ”. That is, the pay structure $F + \delta\Delta I$ can not only incentivize “ g ”, but also avoid the illegal profit of “ b ”. In conclusion, F should be decreased and $\delta\Delta I$ should be increased. For GIAPs, the government concerns not only the costs, but also project schedule and quality. Thus, a reasonable incentive mechanism should comprehensively consider various factors, such as getting the $\delta\Delta I$ hooked on the accident rate in construction stage, follow-up maintenance charges and project schedule, etc. Also, the government should take the energy and water saving realized by using new technology and methods into the category of motivation, considering the energy saving and emission reduction.

(4) Increasing the penalty coefficient μ .

When punishing the agencies, the direct physical punishment is not enough. The reputation losses and credit crisis brought by the notice of criticism are also needed. Thus, apart from increasing physical punishment, an open credit platform should be built to show the violation records of the agencies to the public, which will rule out participants with poor credit records through the evolution of the market mechanism.

(5) Increasing government regulators personnel’s professional ethics

When training the government regulators personnel, uncertainties should be emphasized to make them understand the loss and damage to the government and society caused by failed lax regulation. That will make them more likely do their job with stringent regulation. At the same time, more cautious supervising officers will be selected to reduce illegal incomes, further to avoid dereliction of duty.

CONCLUSIONS

When supervising GIAPs, a scientific and standardized management system should be built by paying more attention to the strategies during project bidding and construction stage. That system will perfect regulation system, avoid the risk caused by asymmetric information, promote revealing the agencies’ information and finally guide the related main body to select strategies based on the long-term strategic vision. In the expectations of infinite times repeat games, a healthy competition mechanism of the market can be established through reducing the probability of the agencies’ illegal participation, increasing the probability of governmental stringent regulation, improving the confidence for governmental stringent regulation,

stimulating “ g ” to manage projects with advanced technology and experience. All the above efforts and suggestion will jointly promote the standardization of GIAPs regulation, which can effectively prevent the damage caused by irregularities to people's life and property safety.

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