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Preventing Adverse Selection Risk of Construction Project Based on Signaling

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Abstract:In the construction market, the adverse selection is very prone to occur as a result of the current situation that the two parties' information is asymmetric, which causes the construction market disorder and uncontrolled market behaviors. For example, in the bidding phase of the project, the owner doesn't know clearly of the contractor's technical strength, level of management, service quality, and so on; also the contractor is unclear of the owner's intention of building, financial capacity, and business reputation etc. at the same time, which leads to adverse selection of bidding market because of inaccurate judgment of the actual risk situation and strength of the contractor. In order to preventing this construction project risk ,this paper is to apply asymmetric information theory to project risk management and finally proves that the contractor 's strength can become the deferent signal of the risk type of the contractor through the analysis of the signaling model based on the contractor's strength. Meanwhile, the owner can judge the risk type of the contractor by acquired the strength and pretended cost of bidding. It is helpful to solve the problem of adverse selection by founding an effective mechanism of signaling, thereby preventing construction project risk.

Keywords: Adverse selection, construction project risk, information asymmetries, risk management, signaling.

1. INTRODUCTION

Under the condition of asymmetric information, the agent may rely on their information advantage to perform some adverse behavior for their own benefit, which raises the two central problems in asymmetric information theory: adverse selection and moral hazard [1]. In the whole life cycle of the project, the various project participants involved always use their information advantage to perform some adverse behavior for their own benefit, which will lead to the project goals failure to be achieved due to the ubiquity of asymmetric information.In recent years, the lack of credit in Chinese construction market is very serious. From the point of view of information economics, asymmetric information gives rise to opportunistic behavior, namely adverse selection and moral hazards, which is the primary cause of breaking faith in the construction market and essentially drives construction project risk [2, 3].

In the bidding phase of the project, the tender doesn't know clearly of the bidder's technical strength, level of management, service quality, and so on; also the bidder is unclear of the tender's intention of building, financial capacity, and business reputation etc. at the same time. So the adverse selection is very prone to occur as a result of the current situation that the two parties' information is asymmetric. The adverse selection caused by asymmetric information leads the Pareto optimality can not be achieved. If the party owned private information has way to pass his own information to the other one or the latter has way to induce the former to provide his private information and then the transaction Pareto improvement can be achieved successfully, which is the so called signaling [4-6].

2. LITERATURE REVIEW

Asymmetric information theory came into being in the 1970s, and had been studied since the pioneering work of the paper of " The Market for "Lemons": Quality Uncertainty and the Market Mechanism" published by George Akerlof, which marks the beginning of the application of the information asymmetry in the commodity market and the beginning of the adverse selection theory [7].

Adverse selection is the dynamic game model of researching asymmetric information, which means the party that holds more information uses other's ignorance of information to conceal relevant information for their own benefits, objectively leading to unreasonable distribution of market. In 1972, the doctoral thesis" labor market signaling" written by Michael A. Spence at Harvard University has a deep research on the cause of information asymmetry between the employer and the applicant. In 1973, he creatively put forward "the signaling theory". In some markets, he pointed out, buyers and sellers can transfer signals of quality information through the market [8-10]. Next Riley (1979) extended the application of the model to general situations of

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information asymmetry besides the labor market [11]. Since then, the signaling theory has been used widely in fields such as credit (Jafee Russell, 1976), finance (Ross, 1977; Bhattacharya, 1979 etc), industrial organization theory (Milgrom, Roberts, 1982) and even social system areas (Mr. Rogoff, 1990) [12-16]. The applications of signaling theory in different areas are almost based on the analysis of how individuals of information superiority effectively convey the information to individuals of information disadvantages through "signaling" to achieve efficient market equilibrium.

From the point of view of information economics, asymmetric information gives rise to opportunistic behavior, namely adverse selection and moral hazards, which is the primary cause of construction project risk. And the problem of adverse selection is particular prominent in domestic construction market. Each contractor's strength level is uneven, which is the fundamental cause of adverse selection. Because of asymmetric information, the owner has little or false information of the contractor's technology, management, credit etc., leading to the owners tend to be at a disadvantage position in the game of both sides, which leads to adverse selection –that is "bad money drives out good money". The signaling model of labor market established by Spence illustrates the influence of educational background signal on signaling [9], Du *et al.* establish a signal screening and incentive mechanism in the market of vehicle insurance [17]. In the light of the situation of information asymmetry of construction market being very similar to labor market as well as insurance market, the signaling theory is gradually applied to the construction market.

In recent years, the construction project risk problems which are caused by adverse selection and moral hazard have drawn attention of relevant scholars: such as Zhao (2002), Wang (2004), Adams (2005) analyzed the risk of adverse selection in the bidding stage and give corresponding solutions in the perspective of qualitative respectively [18-20]; He *et al.* (2004) used the ideas and methods of game theory and principal-agent theory to reveal the unsystematic risk, which is an internal result of adverse selection and moral hazard in the project financing process under the condition of asymmetric information. They built a static model of incomplete information between contractors and owners and a incomplete information dynamic game model between contractors and supervision units, and analyzed the interests relationship between the construction market main body, thus they can design the mechanism and seek the specific ways to prevent and control the risk [21]; Schieg (2008) pointed out that the information asymmetry distribution will lead to adverse selection and moral hazard before and after the implementation of the contract. Based on principal-agent theory, he put forward that we should pay attention to the important role of the specific strategy to against information asymmetry in project management, especially the signal transmission in preventing adverse selection [22]; Xiang *et al.* (2009) presented some counter measures for resolving information asymmetries in project risk management, such as Establishing the signal transduction mechanisms, Signal screening mechanism. Signal filtering mechanism [23, 24]; Xu *et al.* (2011) established a signaling game model of quality management between the contractor and construction unit combining the game theory and information economics theory, and conducted instance analysis finally [25].

Institute of related results achieved for this study provide a foundation and learn from domestic and international issues related to the lack of research and the problems of our project provides a theoretical basis. From the literature, at present, the field of studying with signal transfer to guard against risks caused by adverse selection mostly concentrate in the credit and insurance market. And there are few scholars using quantitative model methods to study the risk of construction project caused by adverse selection. Those measures proposed by previous studies are too broad, lacking of pertinence and the corresponding theoretical support. So, in order to solve the problem construction risk which is widespread in domestic construction market, our main objective in this paper is to found signaling model based on the contractor's strength to transfer the signal of his risk type, thereby preventing construction project due to adverse selection.

3. SIGNALING MODEL

Asymmetric information gives rise to the risk of opportunism in adverse selection, leading to the Pareto optimal transaction cannot be achieved. Signaling model in information economics is the theory of adverse selection, which is the incomplete information dynamic game model with broad practical prospects in economics, management fields. It provides theoretical guidance and technical support for us when we solve the problem of adverse selection.

Assume that the contractor's risk type only have two in the construction market, one is the high-risk and the other is the low-risk, with denoted by H and L respectively. (High risk can be understood as the contractor's reputation, quality of project management, technical strength, operating conditions, etc. are bad, otherwise the opposite). And the two types' strength S is a continuous variable, namely, $S \in [0, \bar{S}]$ With the given strength S and the risk type θ, the contractor's expected output function is

$$y(\theta, C) = \begin{cases} R_H, \theta = H \\ R_L, \theta = L \end{cases},$$

and generally speaking, the higher the contractor's strength, the higher the value of labor productivity and the final project, so the contractor of high strength always obtain higher expected interest; and otherwise the opposite. Namely, $R_H < R_L$. This means that for any given strength S, the productivity of the low-risk contractor is always higher than the high-risk; and for any given risk type θ, the stronger the strength S is, the higher the productivity is.

$U_\theta(R, C)$ is the utility function of the contractor which risk type is θ, where R is the contractor's expected profit.

Suppose that

$$\frac{\partial U}{\partial R} > 0, \frac{\partial^2 U}{\partial R^2} \leq 0, \frac{\partial U}{\partial C} < 0, \frac{\partial^2 U}{\partial C^2} < 0,$$

namely, profit brings positive utility and the marginal utility is diminishing, meanwhile, the strength S also brings positive utility but its marginal cost is increasing. In (R, C) space, we can get an indifference curve with the increasing positive slope. If we suppose that the high-risk contractor's cost of strength is relatively higher than the low-risk's, namely,

$$\frac{\partial U_H}{\partial C} < \frac{\partial U_L}{\partial C},$$

which means that the indifference curve of the high-risk contractor is steeper than the low-risk's everywhere in geometry, with shown in Fig. (**1**) [26-30].

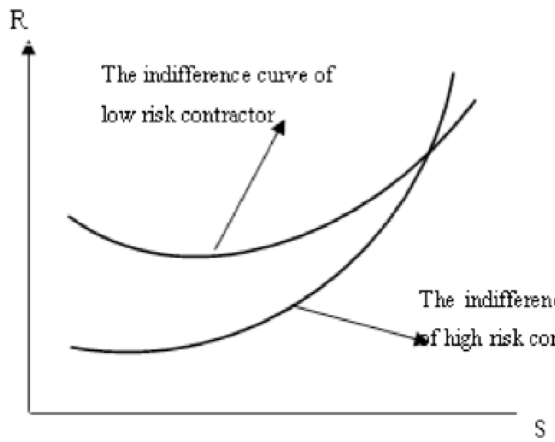

Fig. (1). The indifference curve.

The contractor's problem is to set the expected revenue R and select the strength S, then maximize the utility function. In complete information, the competition between contractors makes the equilibrium income equal to the productivity, namely, $y_H = R_H$, $y_L = R_L$. The optimal conditions are as follows:

the high-risk contractor:

$$\frac{\partial R_H}{\partial S} = \frac{\partial y_H}{\partial S} = -\frac{\partial U_H / \partial S}{\partial U_H / \partial R_H}$$

the low-risk contractor:

$$\frac{\partial R_L}{\partial S} = \frac{\partial y_L}{\partial S} = -\frac{\partial U_L / \partial S}{\partial U_L / \partial R_L}$$

namely, the optimal solution is the tangent point of the indifference curve and output function.

In Fig. (**2A** and **B**) are the equilibrium point of the high-risk contractor and the low-risk contractor respectively. At the same time, the strength selected by the high-risk and the low-risk are S_1 and S_2 respectively, and their returns are R_1 and R_2 separately. Here, the contractor's strength raises his himself productivity. Even under the condition of complete information, each contractor will select the positive strength and the low-risk contractor's strength is much more than the high-risk's.

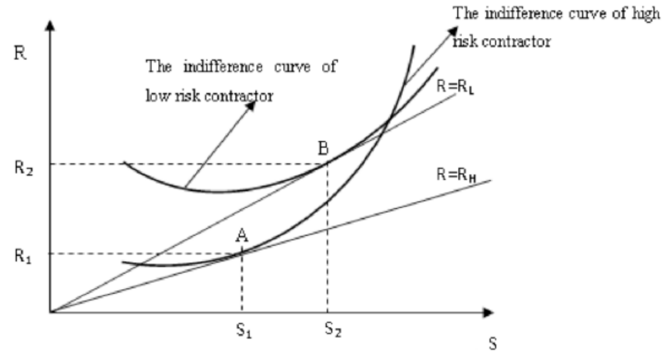

Fig. (2). Equilibrium in complete information.

However, (A, B) can't constitute an equilibrium under information asymmetry, which is because if the contractor expects the owner pay R_2 to the contractor whose strength is S_2, then the high-risk contractor will select S_2 as well, which means the owner's expected profit will be negative.

Assume that the prior probabilities of the contractor belonging to high-risk and low-risk are equal, with denoted by $P(H), P(L)$ respectively. Let's suppose $\mu(S) = P(\theta = H|S)$ is the posterior probability of the contractor belonging to high-risk when the owner observes the contractor to choose the strength S, and $1-\mu(S)$ is of course the posterior probability of the low-risk. Then, under asymmetric information, Bayesian equilibrium can be defined as follows:

(1) there is an expected revenue function $R(S)$,and a strength $S^*(\theta)$;

(2) a posterior probability $\mu(S)$, so as to:

(P1) For the given $R(S)$, to maximize $U_\theta(R(S), S)$;

(P2) $R(S^*) = P(S^*) \times R_H + (1 - P(S^*)) \times R_L$;

(B) $\mu(S)$ Is consistent with Bayes' rule, namely:

$$\mu(S) = P(\theta = H|S) = \frac{P(H)P(S|H)}{P(S)}$$

$$= \frac{P(H)P(S|H)}{P(H)P(S|H) + P(L)(P(S|L)}$$

Condition (P1) is the incentive compatibility constraint, for the given expected revenue function, the contractor which risk type is θ will select $S^*(\theta)$ to maximize his own utility function; condition (P2) is the participation constraint, the reward paid from the owner to the contractor is equal to the contractor's expected output in equilibrium; condition (B) is the Bayesian condition.

Although the contractor's strength is a continuous variable, contractors of the same risk type select the same strength in the equilibrium case. While in separating equilibrium, contractors of different risk type will select different strength, so the owner can judge the risk type of the contractor by acquired his strength in this condition. Specifically, the contractor which risk type is $\theta = H$ selects $S^*(H) = S_1$ and the $\theta = L$ select $S^*(L) = S_2$ what's more, $S_1 \neq S_2$. In pooling equilibrium, contractors of two kinds of risk type select the same strength $S^*(H) = S^*(L) = S^*$, then the owner can't judge the risk type of the contractor according to their strength, thereby the owner can only pay the same reward:

$$R(S^*) = 0.5 \times R_H^* + 0.5 \times R_L^* = \frac{1}{2}(R_H^* + R_L^*)$$

Separating equilibrium is not unique, there exists different separating equilibrium corresponding to different revenue functions, there is only one reasonable separating equilibrium [31], namely, the point of A and B. And the point C is the interaction of R(s), the revenue function of low risk contractor RL and the indifference curve of high risk contractor. This can be illustrated by Fig. (**3**).

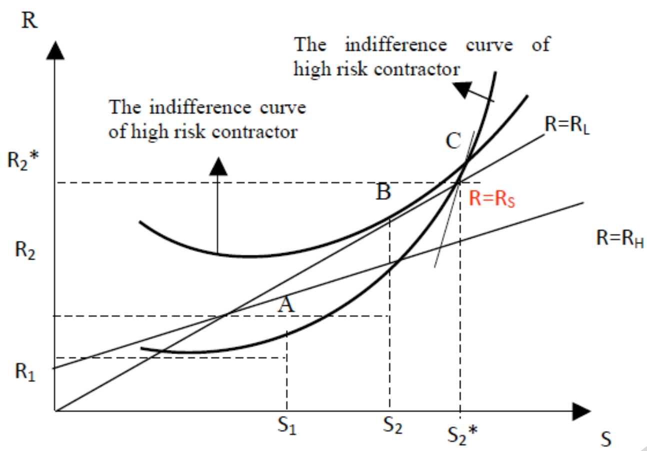

Fig. (3). Pareto Separating Equilibrium.

Regardless of the contractor's risk type being $\theta = H$ or $\theta = L$, for the given strength S, his expected revenue will be between R_H and R_L namely, $R_H \le R(S) \le R_L$. Given this, the high-risk contractor's optimal selection is always $(S = S_1, R(S_1) = R_1)$ for any separating equilibrium, which is the same with the condition of complete information. For all contractors of high-risk, regardless of the posterior probability, all $S \ge S_2^*$ are weakly inferior to S_1. So the owner shouldn't consider the contractor to be high-risk as soon as (when) he is conscious of $S \ge S_2^*$, namely, for all $S \ge S_2^*$, the reasonable revenue function should be $\mu(S) = 0$, when the owners observed, the owners should not think the contractor is a high risk should be for all reasonable posterior probability, and thus should be $R(S) = R_L$, which is shown in Fig. (**3**). Thus,the low-risk contractor is unnecessary to choose the strength to be smaller than S_2^*. In other words, S_2^* is the maximum strength which the low-risk contractor use to distinguish himself from high-risk contractors. So, there exist only one reasonable separating equilibrium (A, C). Namely, the high-risk contractor selects the strength $S = S_1$ while the low-risk selects the strength $S = S_2^*$. Thus, the owner will can of course regard the contractor which strength $S = S_1$ as the high-risk, and $S = S_2^*$ as low-risk. So the owner paies $R = R_H$ to the former and paies $R = R_2^*$ to the latter. Here, $\Delta S = S_2^* - S_2$ is the least additional strength gap of realizing separating equilibrium, namely, the contractor 's strength can become the deferent signal of the risk type of the contractor. Meanwhile, the owner can judge the risk type of the contractor by acquired the strength .It is helpful to solve the problem of adverse selection by founding an effective mechanism of signaling, thereby preventing construction project risk.

4. DISCUSSION

Adverse selection problems' being not solved is mainly due to the lack of effective information disclosure and information transfer mechanisms [32, 33]. And in reality, effective signaling can solve the adverse selection problem.

In the construction market, the transmission of information in two styles: one is the credit signaling, namely, the agent uses his own reputation developed from his past experience to pass on a signal to the client, indicating that his own private information is true; Second, information disclosure, namely, the agent provides information to the client through some special files for client's reference. The client will regard the agent's reputation as an important evaluation index when he selects agent, which is because the project implementation needs the agent's strength, experience, credibility, moral qualities and so on, and these all are private information of the agent. As revealing the personal information costs much, the signaling model of the contractor's strength would be a method of costing low. Because the formation of reputation is a long process, which is aspect from various circles instead of the client's deliberately propaganda. Because of the fierce competition of the construction market, the contractor often natively provides his own past performance to the owner to pass on its internal information, in order to attract the attention of the owner [34].

CONCLUSION

The widespread problem of adverse selection in the construction market is the main reason for the dishonesty of the construction market and is the primary cause of the construction project risk as well. If the problem of adverse selection can't get effective settled, it will be difficult to form a "win-win" situation in the construction market, which leads to the harmonious project management being not formed. The signaling model of the contractor's strength indicates that the contractor's strength of bidding can become the deferent signal of the risk type of the contractor. Meanwhile, the owner can judge the risk type of the contractor by acquiring the contractor's strength of bidding, thereby avoiding the happening of adverse selection and reducing construction project risk.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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