

## Game Theory Analysis of the Bribery Behavior

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### Abstract

*Bribery may destroy the social welfare. In this paper, we investigated the mechanism of the bribery behavior based on the non-cooperative static game theory. With the general presumption of "rational player", two bi-matrix game models are established to analyze the strategy choice of the briber and the bribee. After discussing the cost-benefit of the players, some beneficial conclusions and solving measures are drawn out.*

**Keywords:** Game theory, Bribery, Nash equilibrium, Social welfare

### 1. Introduction

Corruption has become international concern. Bribery is one of the important manifestations of corruption, and its purpose is, through the exchange of money and power, to get reciprocity of benefits. As early as 2000 years ago, Aristotle had judged the exchange behavior: almost all of the people hope to be lofty in concept but choice utility on behavior. Therefore, we can fully identify it as one of the most fundamental assumptions (of social sciences): people are all hope to get and expand their own interests in their life, which is corresponding to the basic assumption of the "rational players" in game theory. As people gradually realize the severity and catholicity of corruption, some empirical researches about the causes and consequences of corruption has been done. Rijckeghem *et al.* (1997) proved increasing officials' income can make the corruption greatly reduce and the Gupta *et al.* (1998) analyzed the influences of corruption to social income distribution, and they thought corruption can lead to poor. Abbink *et al.* (1999) used an interactive laboratory test to prove that reciprocal motive is reasons of producing bribery, and determine the variable influencing corruption by changing the test environment. These empirical studies about corruption are already well reveals the consequences of corruption, however, it is very difficult to reveal the generating reason of bribes.

As is known to all, bribery is a result of players choosing their optimal strategies after considering their own and each other's actions. When bribing more than certain limit both sides' action constitute a crime, so they will prior do their best to obtain other's related information, cautious, later transpired action to keep secret. Therefore we will consider the one-time bribery behavior, which is a typical non-cooperative complete information static game problem. At present the research about this aspect is less, in view of bribery behavior and our culture and custom of regional correlation, this literature is mainly focused on the domestic, Jiang *et al.* (1999) have conducted economic analysis of the corruption in the supervisory process, from the standpoint of information asymmetry analyzed the regulation corruption generated conditions and preventive measures, Xie (2005) use game model, the decision tree and psychological analysis method to analyzed the bribery behavior motive, proposed policy proposals: "high-salary for clearance", "improving the legal of law" and "the strengthening sound punish". This paper will depth analysis the mechanism of bribery behavior from the perspective of non-cooperative static game and establish the bi-matrix game model to describe the interactive relations about the briber and bribee and between the bribers based on the basic assumptions of "rational players". And through cost-benefit analysis of players', we try to put forward corresponding preventive measures based on the fundamental causes of this phenomenon.

### 2. Game Analysis between Briber and Bribe

#### 2.1 Cost-benefit analysis of the players

In bribery behavior, what bribers and bribees exchange is their interest. The briber want to obtain benefits which is far outweigh cost, and the bribee are will to exchange for bribe's "gift" with their power by offering bribers things and benefits which bribers shouldn't or maybe can't get in normal conditions, then, this is the general bribery pattern.

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In this decision-making process, bribe-givers would like to fully consider the possible decisions of bribees, because that would greatly influence their income, similarly, bribees also should fully consider the possible decision-makings of bribe-givers when they make a choice. In other words, both of them maximize their own profits under considering others' decisions. Here we analyze the above process with static game. There are two players, that is briber and bribee. They each have two pure strategies that is bribery and no bribery, and different strategy combinations lead to different payment value. To make sure their earnings, we must firstly analyze their costs and benefits, which is the primary requirement to obtain the equilibrium of this game.

Denote the two players as A (bribee) and B (briber). Without loss of generality, suppose the two players have a better understanding of each other (namely it is a game with completely information). Player A grasps certain power and interests which player B expects to get from A. Obtained such interests through bribery, player B can get additional revenue  $c$  than competition. However, in addition to the bribery cost certain risks, the briber will suffer certain mental torture for his behavior. Here denote the bribery's cost as  $d$  which consists of the currency material cost, moral cost and risk cost. Of course, if player B participates the game through legitimate competition instead of bribery, the above all sorts of "cost" will be zero, and at the same time, his extra income is zero too. It still has another kind of disturbing situation that is player B chooses bribes while player A chooses not to bribe. Under such kind of circumstance, player B also needs pay a certain cost, denote as  $e$ .

For player A, when player B bribes to him, he weighs the interest and carries on psychological struggle before deciding whether to accept bribery. Here he has two choices: accept bribes or refuse to bribes. If he refuses to bribers and keeps honest, he will get moral satisfaction of honest reputation and psychological security, even become a charming story from now on, so we assume under this situation he's payoff is  $b$ . Otherwise, if he accepts bribers, then he will change public power for a certain amount of bribery, and denote his payoff as  $a$ . However, he has to endure the psychological torture and behavioral risk from his corruption. According to the present system and related psychology knowledge, we assume that the risk cost and moral prices he paid is equal to the interest for refusing to bribery. Based on the above analysis, we can describe the game with the following matrix (table 1) in which each pair of numerical value in brackets represent the payoff value of the player A and B respectively.

## 2.2 Nash equilibrium analysis

As we all know, both of the players pursue profit maximization. Therefore, we assume  $a, b, c, d > 0$  and  $a > 2b, c > d$  for revenue and costs of the players. The mechanism of the game is that players choose the optimal strategy which maximizes their own profit under considering other players' strategies. Here the eliminating dominated strategy method is employed to search the Nash equilibrium of the above game. Through the above payoff matrix we can see, for player A, no matter what strategy player B chooses, his payoff from "bribe" always not less than the payoff from "no bribe", namely,  $a - b > b, 0 = 0$ . Therefore, in pure strategy set of player A, "bribe" is superior to "no bribery". Similarly, for player B, because of  $c - d > 0, 0 = 0$ , the pure strategy "bribe" is strictly dominant strategy. Then with the eliminating dominated strategy method, it is easy to get the unique Nash equilibrium point of the game, that is, "(bribery, bribery)". In addition, we can find that the Nash equilibrium point "(bribery, bribery)" is also Pareto optimal solution. Thus, players further strengthen the determination of bribery. The above analysis explains the Chinese proverbs "Throw a long line to catch a big fish", "if you can not give up your baby, you will never meet a colorful wolf" etc. excellently, which reflects the psychological activity of the briber.

## 3. The Analysis of Briber's Motivation and the Cause of Bribee's Risk

The above analysis has given us the revelation: Nash equilibrium of the bribery game is closely related to players' costs and revenue. The reason why the eliminating dominated strategy method can be used because we gave the hypothesis  $a > 2b$  and  $c > d$ , which shows both player's benefits are much higher than their cost in a successful bribery process. If we change their payoff through the following two ways:

(1) Increasing the risk of costs and moral bribe-givers cost:

(2) Increasing the rewarding strength to no bribery and regulatory penalties of bribery behavior, in other words, changing the costs of bribees, and once they have bribery intent, even without really charge of bribery, they will be punished accordingly.

Therefore, under such policy, the payoff matrix of the game can be re-written as table 2. Now we analysis the Nash equilibrium of the new game. Assuming at the point of Nash equilibrium, player A's optimal strategy is  $(p, 1-p)$  and the optimal strategy of player B is  $(q, 1-q)$ , i.e. player A choose the strategy "bribe" with the probability  $p$  and choose the strategy "no bribery" with  $1-p$ , similarly, player B choose his strategy "bribe" with  $q$  and strategy "no bribery" with  $1-q$ .

So player A considers to choose an appropriate probability to optimize the following parametric programming ( $P_A$ ):

$$\max pq(a-b) + (1-p)qb - bp(1-q) \quad (1)$$

It is easy to obtain the solution to the unconstrained optimization problem,

$$q^* = \frac{b}{b-a} \quad (2)$$

Here we can see, the optimal probability  $q^*$  of player A increases with the increase of the parameter  $b$ . That is to say, as the cost of player A increases, the probability of choosing "no bribe" increases.

Similarly, as for player B, he should solve the following programming ( $P_B$ ):

$$\max pq(c-d) - eq(1-p) \quad (3)$$

And the optimal solution is

$$p^* = \frac{e}{c-d+e} \quad (4)$$

Thus we obtain the Nash equilibrium of the new game is a mixed strategy situation  $((p^*, 1-p^*), (q^*, 1-q^*))$ .

Here we can see, when the parameter  $e$  increases, the optimal probability  $p^*$  increase. That is to say, as the cost of player B increases the probability of choosing "no bribe" increases. With the above analysis, we discover some deep-seated reasons. In the real life, although bribers suffer the moral condemnation and legal sanctions, bribery behavior is still long-standing. The fundamental reason lies in its inherent economic factors, and also has reasons for monitoring and reward and punishment systems. Explained in detail on the one hand, it is difficult to make a clear distinction between legitimate and illegitimate exchange in social interpersonal interaction process, and it is harder to count on they expose each other because of their consistency in interests. On the other hand, everyone hopes to expand his own interests. The players in bribery game are all rational to pursue their own utility maximization. Although we all condemn such behavior, but if there is such a need, everyone will emerge such a motive and have the potential to act. So, besides guiding people's attitude to correctly deal with the "personal optimal" and "socially optimal", the improvement of bribery behavior rewards and punishment system is one of the compulsory feasible methods. When the pay is much larger than the gain, no one has incentive to bribe.

#### 4. The Nash Equilibrium between Bribers

In real life, many bribe-givers may not approve this kind of behavior from the bottom of their hearts, but compelled by the helplessness of this kind of unhealthy practices, the bribery behavior of the competitors and the director or supervisor. They may be under the apprehension that the competition becomes unfair because of the competitors' bribery. Then, they will have nothing to regret after doing the same thing. So it is necessary to analyze the game between bribers. Here we consider the static game with complete information and there are only two players, denoted as player a and b. In reality, bribery behavior frequently occurs in the circumstance that the players are nip and tuck. Every player's has two pure strategies, bribery and no bribery. And the payoff matrix is shown in Table 3. Where  $a_i, b_i, c_i, d_i$  are all nonnegative ( $i=1,2$ ). From the cost-benefit analysis of the briber, we know that, given the opponents' strategy, players' profit from bribery are always not less than one from no bribery, so we have  $a_i \geq c_i$  and  $b_i \geq d_i$  ( $i=1,2$ ). And then it is easy to get the unique Nash equilibrium point of the game with the eliminating dominated strategy method, that is "(bribery, bribery)".

In condition that player a and b are upside (including bribery amount), there is an implied condition in the payoff matrix:  $d_i \geq a_i$  ( $i=1,2$ ). In fact, when both sides choose "no bribery" and compete fairly, both of their expected utilities (i.e. payoff values) are equal, namely  $d_1 = d_2$ , if both are to bribery, then their payoff values are the margin of the expected utility and the amount of bribery, respectively. So there will be  $d_i \geq a_i$  ( $i=1,2$ ). At this time, the game is a "prisoners' dilemma" apparently. The Pareto optimal solution of the game is not the unique Nash equilibrium point but the situation "(no bribery, no bribery)". The above discussion suggests that cooperation is a beneficial "self-serving strategy". However it requires players to treat others in the light of the way that you are willing to others treating you, but just also requires them to adopt the same way. Also is the Chinese saying "Do not do to others what you don't want to be done to you". But only if people do not want to do unto me.

#### 5. Discussion and Suggestions

In the final analysis, the generating of bribery is due to that the expected revenue of players is more than their costs. Punishing the bribers severely afterwards is a temporary solution but how to effect permanent cure?

We should take measures according to the factors that influence the briber's decision,

reducing his psychological expected net revenue so that the briber can't obtain extra profit and even get more kicks than halfpence. Specifically, there are many other reflections as follows.

(1) Increasing bribery costs and reducing both expected returns.

Generally speaking, bribery behavior is negatively related with the cost, and positively related with the expected revenue, namely the higher cost, the less bribery behavior, while the greater expected revenue, the more bribery behavior. Therefore, we can increase the cost of both briber and bribe through various ways, such as decentralize centralization, severe punishment, tighten supervision, etc. Among them, cutting official's power is the essential strategy. Professor Lord Acton from England's Cambridge University said: "power tends to corrupt, and absolute power leads to corrupt absolutely." Cutting the official's power will dispel the bribery motivation and increase the risk of bribery. Then, cost running up and benefit plunging, the strategy "bribe" or "bribe" is no longer dominant to both players.

(2) Establishing a good competitive incentive mechanism, Fostering and adhering to the correct guidance of public opinion and action. Whether in economic activities or in political activities, we should actively advocate, in public opinion and actions, the fair competition mechanism, strictly disciplinal and encouraging methods. Thus it can indirectly reduce bribers' earnings, also can reduce their motive for this kind of behavior. In addition, the briber is also hard to dominate government expense to bribe in the strict supervision and recall system and the bribee is also difficult to change power for "gray income".

(3) Perfecting market regulations and creating a credit environment.

Setting up and implementing the correct evaluation mechanism makes participants conduct equal competition. As long as there are perfect regulations for the market to escort, it can make fair competition. It requires normative order, uniform standard to eliminate unfair swap behavior. When looking for mayor is no better than finding the market, it not only can end dirty political, but also can add a brushstroke for harmonious society building. In addition, in the whole society we should build honest good environment. There is a Chinese proverb says "Man can't do anything without a good credit, business must be fading without a good credit and countries will be dangerous without a good credit". So the bribers will lose more than obtained based on the personal credit records.

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**Table 1** the game between bribers and bribees

	A	
B	Bribery	No bribery
Bribery	(c-d, a-b)	(-e, b)
No bribery	(0, 0)	(0, 0)

**Table 2** the new game of bribers and bribees

	A	
B	Bribery	No bribery
Bribery	(c-d, a-b)	(-e, b)
No bribery	(0, -b)	(0, 0)

**Table 3** the game between bribe-givers

	B	
A	Bribery	No bribery
Bribery	(a <sub>1</sub> , a <sub>2</sub> )	(b <sub>1</sub> , c <sub>2</sub> )
No bribery	(c <sub>1</sub> , b <sub>2</sub> )	(d <sub>1</sub> , d <sub>2</sub> )