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(Citation)
國民經濟雜誌,217(5):73-85

(Issue Date)
2018-05-10

(Resource Type)
departmental bulletin paper

(Version)
Version of Record

(JaLCDOI)
https://doi.org/10.24546/E0041490

(URL)
https://hdl.handle.net/20.500.14094/E0041490

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国民経済雑誌　第217巻　第5号　抜刷
平 成 30 年 5 月

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This paper considers a first-price procurement auction with two contractors where there is a positive probability that the government official revises the bid of the favored contractor after all contractors submit their bids. Being cautious to the possibility of corruption makes the disadvantaged contractor bid more aggressively than when there is no possibility of corruption, whereas the advantaged contractor preserves its aggressiveness since corruption may not be practiced. The disadvantaged contractor's aggressive bidding creates the case where corruption is not practiced and the disadvantaged contractor with higher costs wins the auction, which is inefficient in allocation.

Keywords Procurement auctions, Corruption, Right of first refusal

1 Introduction

In this paper, I examine the impact of corruption on contractor bidding behavior, expected price and allocation when the implementation of corruption schemes is uncertain. Corruption is a major problem in both developed and developing countries. According to reports by the Department of Justice and Federal Bureau of Investigation in the United States, there were 20,446 cases of stimulus fraud in the private sector between 1988 and 2007. Because corruption can increase contract prices and result in an inefficient allocation of contracts, many researchers have explored the impact of corruption on the outcomes of procurement auctions. However, the possibility that the expected corruption schemes might not come to fruition has been ignored. Practically speaking, it seems important to recognize that corruption schemes are not always guaranteed to be enacted. Because regulatory authorities consider corruption to be a serious problem, more thorough work is being done to uncover corruption, and the practice of corruption schemes may depend on the judgements of corrupt government officials' regarding how stringent the oversight process is.

Corruption is a type of implicit contract between a briber and bribee, and one of corruption's features is that it is illegal. Because it is illegal, the implementation of the contract is kept secret. Thus, other contractors are not aware of and are not involved in the corrupt scheme, though they may be aware of the potential existence of a corrupt relationship between specific contractors and government officials. For the same reason, corrupt contractors cannot take government officials to court when corruption schemes are not implemented. In other words, the corrupt government is not necessarily committing to following through with these schemes. The only way for a corrupt contractor to make implicit illegal contracts credible is to control the timing of payment at the close of auctions. However, such a bribery-payment scheme can only decrease, rather than eliminate, the risk of paying government officials to execute a plan on which they do not follow through. How the use of corruption schemes might affect the prices of the procured projects and the efficiency of project allocation remains unclear.

I consider the following situation. In a one-shot, two-stage game, the government procures a project, and it has a collusive relationship with one of its contractors via a corruption scheme. Under the scheme, the government official can revise the bid submitted by the corrupt contractor (called the advantaged contractor in this paper) before the amount of the bids becomes public information; thus, the advantaged contractor will be awarded the contract unless the bid submitted by the opponent (called the disadvantaged contractor) is lower than advantaged contractor's costs. When the advantaged contractor wins the auction outright, the government official makes changes that allow the advantaged contractor to derive a greater surplus from the contract. The payment from the advantaged contractor to the government official is a portion of the advantaged contractor's surplus. However, such plans do not always come to fruition. The existence of collusive relationships and of possible corruption schemes is common knowledge, but whether such plans are actually executed is uncertain.

Using this scheme specification, I create a situation in which the advantaged contractor can be almost automatically awarded the project without making his own strategic moves as long as the corruption scheme is executed. By adding the question of uncertainty to the problem of corruption schemes, I focus on the advantaged contractor, who joins the competition and chooses his bid strategically. The results indicate that inefficiency in project allocation can occur when the plan is not executed. The implications are as follows. Because the disadvantaged contractor knows about the potential for corruption, he bids more aggressively than the corrupt contractor, but it is uncertain that corrupt behavior will occur. As a result, the projects will be awarded to the contractor whose costs are higher.

This paper continues as follows. In section 2, I briefly review the past literature, summarize the major topics and findings in the field of corruption in procurement auctions, and discuss what can be done to extend prior research. In section 3, I construct a model of corruption in a sealed bid first-price procurement auction with an uncommitted government official. In section 4, I first show the bidding behavior of contractors and discuss the allocation of contracts in fair procurement auctions as a benchmark. Next, I model a corrupt procurement auction in which the government official does not commit to the corruption scheme in order to characterize the equilibrium. After the description of setting, I present the characteristics of the bidding behavior of contractors and explain the potential inefficiency of this game.

2 Related Literature

Many of the related studies distinguish themselves from one another by using different corruption schemes and by using different definitions of corrupt contractors. In many settings, the corrupt government allows the corrupt contractor revise his or her bid after all bids are submitted. This means that a sequential auction occurs in which the corrupt or advantaged contractors bid after the honest contractors and corruption does not cause inefficiency, even though the expected prices are higher than in fair auctions (Menezes and Monteiro, 2006; Lee, 2008; Burguet and Perry, 2007; Lengwiler and Wolfsetter, 2010). However, if there is a factor that drives honest or disadvantaged contractors to bid more aggressively than corrupt contractors, then inefficiency occurs (Burguet and Perry, 2007; Lee, 2008).

The studies most closely related to the present study are Arozamena and Weinschelbaumb (2009) and Burguet and Perry (2009). Burguet and Perry (2009) employ a corrupt arrangement in which the government allows the corrupt contractor to revise the bid only when the contractor fails to submit the lowest bid, whereas regular right of first refusal allows the contractor to revise his bid even when he wins the auction outright. Because the government does not help the corrupt contractor when he wins the auction outright, the contractor does not pay a bribe to the government, which means that the corrupt contractor may enjoy a higher surplus than when he loses the auction during the first round but wins it by revising his bid. The essential factor is the size of the payment for bribery relative to that of the total possible surplus. In this case, the corrupt contractor has an incentive to join the competition from the beginning, which makes the auction game simultaneous and less inefficient.

Arozamena and Weinshelbaumb (2009) use a strategy similar to mine in that at least one of the contractors does not know that a corrupt relationship exists between the government and the opponent. The honest contractor assigns positive probabilities to both the possibility that corruption will be practiced and the possibility that it will not be. This suspicion leads the honest contractor to bid more aggressively than in a usual fair auction but less aggressively than when it is certain that the corruption scheme will be executed. However, their setting does not allow the corrupt contractor to face a simultaneous game. The only focus is on the bidding behavior of honest contractors, whereas my concern is the corrupt contractor's behavior.

3 The Model

3.1 Information

Consider a situation in which a government official procures a public project. This is a two-stage game with two contractors competing for the project. Each contractor is denoted as either the advantaged contractor or the disadvantaged contractor by A or D, respectively. ($i \in \{A, D\}$). The advantaged and disadvantaged contractors are defined by whether each has an implicit contract with the government. I describe the contract in the next subsection. Contractor i has a project completion cost of c_i. Completion cost c_i is randomly distributed iid over the interval $[\underline{c}, \bar{c}]$. Let $F(c_i)$ be the probability cumulative function, and let $f(c_i)$ be the corresponding density function. A contractor's (completion) cost is private information. I assume that $F(\cdot)$ is differentiable and that $f(\cdot)$ is continuously differentiable in $[\underline{c}, \bar{c}]$. The probability that the procurement auction is the target of a corruption scheme orchestrated by the government official and the advantaged contractor is $1-p>0$. The probability is common knowledge, but the corruption scheme is implemented only after the auction is closed.

3.2 The vNM Utility Function and the Corruption Scheme

The vNM utility functions in this game are represented as follows. Let b_A be the advantaged bidder's bid in the procurement auction. If the corruption scheme is not practiced (recall that the occurrence of collusion is revealed to the advantaged contractor only after he submits the bid) and if the advantaged contractor submits the lowest bid, then the contract is awarded to him. In such cases, the advantaged contractor's vNM utility is $b_A - c_A$. However, if his bid is not the lowest, then the advantaged contractor's vNM utility is 0.

If the corruption scheme is practiced, the government official revises the advantage contractor's bid to the disadvantaged contractor's bid unless the disadvantaged contractor's bid is lower than the advantaged contractor's cost (i.e., $b_D < c_A$), with the payment share $1-\lambda (0 \leq \lambda \leq 1)$ and the contract is awarded to the advantaged contractor. In this case, the advantaged contractor's vNM utility is $\lambda(b_D - c_A)$.[1)] Here, it is assumed that the advantaged contractor shares cost-related information with the government officials.

The vNM function for the advantaged contractor $(i=A)$ is given by

$$\pi_A^{Fair}(c_A, b_A, b_D) = \begin{cases} b_A - c_A & \text{if } b_D > b_A \\ \frac{1}{2}(b_A - c_A) & \text{if } b_D = b_A \\ 0 & \text{otherwise.} \end{cases} \quad (1)$$

$$\pi_A^{Corrupt}(c_A, b_D) = \begin{cases} \lambda(b_D - c_A) & \text{if } b_D \geq c_A \\ 0 & \text{otherwise.} \end{cases} \quad (2)$$

whereas that of the disadvantaged contractor $(i=D)$ is given by

$$\pi_D^{Fair}(c_D, b_A, b_D) = \begin{cases} b_D - c_D & \text{if } b_A > b_D \\ \frac{1}{2}(b_D - c_D) & \text{if } b_A = b_D \\ 0 & \text{otherwise.} \end{cases} \quad (3)$$

$$\pi_D^{Corrupt}(c_D, c_A, b_D) = \begin{cases} b_D - c_D & \text{if } c_A > b_D \\ 0 & \text{otherwise.} \end{cases} \quad (4)$$

3.3 Expected Profit

The expected profit functions are as follows. The advantaged contractor's expected profit is given by

$$\begin{aligned} &\Pi_A(b_A, | c_A, c_D) \\ &= p(b_A - c_A)[1 - F(\beta_D^{-1}(b_A))] \\ &\quad + (1-p)\lambda\Big[\int_{\beta_D^{-1}(c_A)}^{\beta_D^{-1}(b_A)} (\beta_D(x) - c_A)dx + \int_{\beta_D^{-1}(b_A)}^{\bar{c}} (\beta_D(x) - c_A)dx\Big]. \end{aligned} \quad (5)$$

The first term starting with p is the expected profit when the corruption scheme is not practiced. Then, the auction is a fair ordinary first-price sealed-bid procurement auction, and the advantaged contractor wins the auction with a probability of $1 - F(\beta_D^{-1}(b_A))$. The second term is the expected profit when the planned corruption scheme is implemented. The first term in square brackets is the expected profit when the advantaged contractor fails to submit the lowest bid, and the government official revises it to b_D if $b_D \geq c_A$. The second term in square brackets is the expected profit when the advantaged contractor successfully submits the lowest bid, and the government official revises b_A to the level of the disadvantaged contractor's bid b_D so that the advantaged contractor has the greater surplus. The disadvantaged contractor's expected profit is given by

$$\Pi_D(b_D, \mid c_A, c_D) = p(b_D - c_D)[1 - F\big(\beta_A^{-1}(b_D)\big)] + (1-p)(b_D - c_D)(1 - F(b_D)). \quad (6)$$

The first term is the expected profit when the scheme is not practiced, whereas the second term is the profit when the scheme is practiced. In such a case, the disadvantaged contractor must match the advantaged contractor's cost rather than his bid. Therefore, the probability of winning is $1-F(b_D)$. Based on these settings, I obtain the Bayesian Nash equilibrium of this game.

4 Equilibrium Analysis

In this section, I determine the equilibrium in this game and provide the implications of the factors at play. Because contractors have an identical cost distribution but exhibit different utility functions, the strategies in equilibrium are expected to be asymmetrical. Because proving the existence and uniqueness of the Bayesian Nash equilibrium is not the focus of this game, I omit the proof here and simply note the conditions for the game. However, one can reference the proof presented in Lebrun (1999) for more information.

The corruption scheme is practiced with the probability one ($p=0$) and zero ($p=1$). When the corruption scheme is practiced with the probability of one ($p=0$), the advantaged contractor submits any bid $b_A \in \mathbb{R}_+$ because this value is changed by the government official to b_D if $b_D \geq c_A$, which means that disadvantaged contractor chooses his strategy as if he faced his opponent's bid function

$$\beta_A^*(c_A \mid p=0) = c_A. \quad (7)$$

The disadvantaged contractor's bid function satisfies the first-order condition

$$1 - F(b_D^*) + (c_D - b_D^*) f(b_D^*) = 0, \quad (8)$$

where $b_D^* = \beta_D^*(c_D \mid p=0)$. If $c_D > c_A$, the advantaged contractor wins because $b_D^* \geq c_D > c_A$, and if $c_A > c_D$ and $c_A - c_D > (1-F(b_D^*))/f(b_D^*)$, the disadvantaged contractor wins. In these cases, the efficiency in project allocation is achieved. However if $c_A > c_D$ and $c_A - c_D < (1-F(b_D^*))/f(b_D^*)$, the project allocation is inefficient and this may be one of the reasons that the collusive behavior between the government and contractors is regulated.

When the probability that the corruption scheme will be executed is zero (i.e., $p=1$, which indicates a fair auction), the advantaged and disadvantaged contractors have symmetric bid functions that satisfy the following first-order conditions.

$$1-F\left(\beta_j^{-1}(b_i)\right)=(b_i-c_i)f\left(\beta_j^{-1}(b_i)\right)\frac{d\beta_j^{-1}(b_i)}{db_i}. \tag{9}$$

Again, in this case, there is no inefficiency in project allocation.

Let us consider the case where the probability that the corruption scheme will be practiced is $p(0<p<1)$. Given $(c_A,\ c_D)$, the advantaged contractor's expected profit maximization problem is given by

$$\max_{b_A} p(b_A-c_A)[1-F(\beta_D^{-1}(b_A))]+(1-p)\lambda\int_{\beta_D^{-1}(c_A)}^{\bar{c}}(\beta_D-c_A)dF(c). \tag{10}$$

The disadvantaged contractor's expected profit maximization problem is given by

$$\max_{b_D} p(b_D-c_D)[1-F(\beta_A^{-1}(b_D))]+(1-p)(b_D-c_D)\left(1-F(b_D)\right). \tag{11}$$

Maximization problems (10) and (11) imply the following first-order conditions.

$$1-F\left(\beta_D^{-1}(b_A)\right)=(b_A-c_A)f\left(\beta_D^{-1}(b_A)\right)\frac{d\beta_D^{-1}(b_A)}{db_A},\ \text{and} \tag{12}$$

$$p\left[1-F\left(\beta_A^{-1}(b_D)\right)\right]+(1-p)\left(1-F(b_D)\right)$$
$$=p\left[(b_D-c_D)f\left(\beta_A^{-1}(b_D)\right)\frac{d\beta_A^{-1}(b_D)}{db_D}\right]+(1-p)[(b_D-c_D)f(b_D)]. \tag{13}$$

Equation (12) indicates a marginal condition under a fair sealed-bid first-price procurement auction, which implies that the advantaged contractor bids as if he were participating in a fair procurement auction as long as there is a strictly positive probability that the corruption scheme is practiced. Remember that if $p=0$ (i.e., the corruption scheme is always implemented), the advantaged contractor's optimal choice of bid is any real number because the advantaged contractor wins the auction if the disadvantaged contractor's bid is higher than the advantaged contractor's costs. In such a case, consequently, the disadvantaged contractor needs to behave as if she were facing a sequential auction in which the advantaged contractor would submit his bid after the disadvantaged contractor submitted her bid. However, once the probability of a fair auction becomes strictly positive ($p>0$), the advantaged contractor begins to consider the possibility that the scheme will not be implemented, and the current procurement auction becomes a fair sealed-bid first-price auction in which the advantaged contractor needs to bid simultaneously with the disadvantaged contractor. The portion of the advantaged contractor's payments to the government official has no impact on the advantaged contractor's marginal decision.

By adding two boundary conditions that are common in competitive procurement auctions, I derive the following necessary conditions of the Bayesian Nash equilibrium for this game.

Proposition 1. A pair of pure strategies (β_A^*, β_D^*) in the Bayesian Nash equilibrium for this game satisfies the following conditions.

1. $\forall i \in \{A, D\}$, $\phi_i(\bar{c}) = \bar{c}$,
2. $\exists \underline{b} \in \mathbb{R}$ such that $\forall i \in \{A, D\}$, $\phi_i(\underline{b}) = \underline{c}$,
3. The functions $\phi_A(\cdot) \equiv \beta_A^{*-1}$ and $\phi_D(\cdot) \equiv \beta_D^{*-1}$ are the solutions of the system of ordinary differential equations of

$$\phi_D'(b_A) = \frac{1 - F\big(\phi_D(b_A)\big)}{\big(b_A - \phi_A(b_A)\big) f(\phi_D(b_A))}, \text{ and} \tag{14}$$

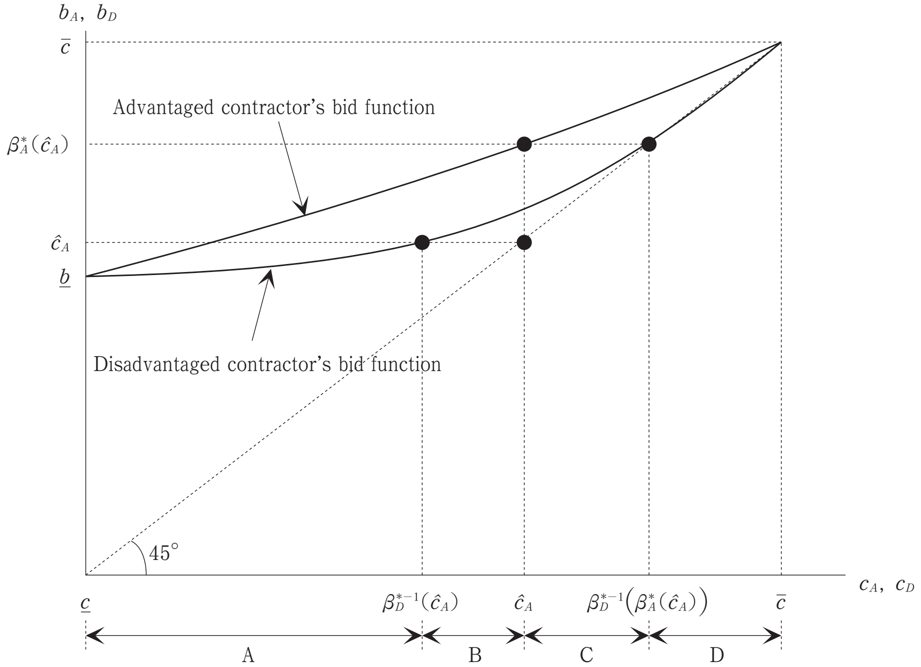
$$\phi_A'(b_D) = \frac{(1-p)\left[1 - F(b_D) - \big(b_D - \phi_D(b_D)\big) f(b_D)\right] + p\left[1 - F\big(\phi_A(b_D)\big)\right]}{p\big(b_D - \phi_D(b_D)\big) f\big(\phi_A(b_D)\big)}. \tag{15}$$

That corruption schemes become more likely to be practiced indicates that the disadvantaged contractor has a higher chance of competing with the advantaged contractor in terms of cost, as that figure is lower than the advantaged contractor's bid. To match his opponent's cost, the disadvantaged contractor shifts his bidding schedule downward, and his lowest bid $\underline{b}_D$ decreases to the lowest cost $\underline{c}$. However, the advantaged contractor considers the other side of the situation. If it is more likely that the government official will implement the corruption plan, then the advantaged contractor will experience softer price competition, and thus, he shifts the bidding schedule upward. At the same time, however, the advantaged contractor knows that it is still possible that the plan will not be implemented and that he may therefore face more aggressive bidding behavior on the part of the disadvantaged contractor under a fair auction. As a result, the advantaged bidder needs to decrease the cost of his lowest bid $\underline{b}_A$ to his lowest possible cost $\underline{c}$. Assuming these conditions and using a numerical approach developed by Bajari (2001), I conducted computations. But, for the sake of saving space, I only describe the contractors' strategies in equilibrium in the next subsection based on the computation. If one needs the numerical result, he can see Horie (2017).

4.1 Efficiency in Project Allocation

Figure 1 provides an insight into how the possibility of corruption and an uncommitted government official can cause the contract to be allocated efficiently or inefficiently. I compare possible combinations of ex-post costs and bids for advantaged and disadvantaged contractors. In a procurement auction with an uncommitted government official, there exist two potential inefficiencies with respect to the costs associated with the advantaged contractor.

Figure 1 Efficiency in Allocation



- **Type I inefficiency:** If the advantaged contractor has a lower cost than the disadvantaged contractor, then the contract may be allocated inefficiently when the corruption scheme is not practiced.
- **Type II inefficiency:** If the disadvantaged contractor has a lower cost than the advantaged contractor, then the contract may be allocated inefficiently when the corruption scheme is practiced.

Case A: $\underline{c} \leq \hat{c}_D \leq \beta_D^{*-1}(\hat{c}_A)$

Suppose that advantaged contractor has the cost of $c_A = \hat{c}_A$ and disadvantaged contractor's cost $c_D = \hat{c}_D$ is in $\underline{c} \leq \hat{c}_D \leq \beta_D^{*-1}(\hat{c}_A)$. Their bids are $b_A = \beta_A^*(\hat{c}_A)$, and $b_D = \beta_D^*(\hat{c}_D)$ respectively. If the corruption scheme is practiced, disadvantaged bidder wins the contract since $\beta_A^*(\hat{c}_A) > \beta_D^*(\hat{c}_D)$ and if the scheme is not practiced, disadvantaged contractor wins the contract again since $\beta_A^*(\hat{c}_A) > \beta_D^*(\hat{c}_D)$. Since $\hat{c}_A > \hat{c}_D$, it is said that the contract allocation is always efficient.

Case B: $\beta_D^{*-1}(\hat{c}_A) \leq \hat{c}_D \leq \hat{c}_A$

Suppose that advantaged contractor has the cost of $c_A = \hat{c}_A$ and disadvantaged contractor's cost

$c_D = \hat{c}_D$ in $\beta_D^{*-1}(\hat{c}_A) \leq \hat{c}_D \leq \hat{c}_A$. Their bids are $b_A = \beta_A^*(\hat{c}_A)$, and $b_D = \beta_D^*(\hat{c}_D)$ respectively. If the scheme is practiced, advantaged contractor wins since $\beta_D^*(\hat{c}_D) > \hat{c}_A$. If the corruption scheme does not occur, disadvantaged contractor wins the contract since $\beta_D^*(\hat{c}_D) > \beta_A^*(\hat{c}_A)$. Since $\hat{c}_A > \hat{c}_D$, it is said that the contract allocation is efficient if the corruption scheme is not practiced, but inefficient if the scheme is practiced.（Type II inefficiency）

Case C: $\hat{c}_A \leq \hat{c}_D \leq \beta_D^{*-1}(\beta_A^*(\hat{c}_A))$

Suppose that advantaged contractor has the cost of $c_A = \hat{c}_A$ and disadvantaged contractor's cost $c_D = \hat{c}_D$ is in $\hat{c}_A \leq \hat{c}_D \leq \beta_D^{*-1}(\beta_A^*(\hat{c}_A))$. Their bids are $b_A = \beta_A^*(\hat{c}_A)$, and $b_D = \beta_D^*(\hat{c}_D)$ respectively. If the corruption scheme is practiced, advantaged contractor wins since $\beta_D^*(\hat{c}_D) > \hat{c}_A$. If the corruption scheme is not practiced, disadvantaged contractor wins the contract since $\beta_A^*(\hat{c}_A) > \beta_D^*(\hat{c}_D)$. Since $\hat{c}_D > \hat{c}_A$, it is said that the contract allocation is efficient if the corruption scheme is practiced, but inefficient if the corruption scheme is not practiced.（Type I inefficiency）

Case D: $\beta_D^{*-1}(\beta_A^*(\hat{c}_A)) < \hat{c}_D$

Suppose that advantaged contractor has the cost of $c_A = \hat{c}_A$ and disadvantaged contractor's cost $c_D = \hat{c}_D$ is in $\beta_D^{*-1}(\beta_A^*(\hat{c}_A)) < \hat{c}_D$. Their bids are $b_A = \beta_A^*(\hat{c}_A)$, and $b_D = \beta_D^*(\hat{c}_D)$ respectively. If the corruption scheme occurs, advantaged contractor wins since $\beta_D(\hat{c}_D) > \hat{c}_A$. If the corruption scheme does not occur, advantaged contractor wins the contract since $\beta_D^*(\hat{c}_D) > \beta_A^*(\hat{c}_A)$. Since $\hat{c}_D > \hat{c}_A$, it is said that the contract allocation is always efficient.

In Type I inefficiency, inefficient contract allocation occurs not due to corruption but due to the cautionary behaviors of the disadvantaged contractor, and this is the key result of this study. Because the existence of a corruption scheme in this context is not something that the participants in the auction are actively aware of, the contractors may bid more aggressively or less aggressively depending on whether individual contractors have an illegal contract with the government officials. Because the contractors are preparing for possible corruption, inefficient allocation can occur even when there is no artificial price manipulation by the government. Type I inefficiency can occur because of the disadvantaged contractor's behavior, which is predicated on his knowledge that a corruption scheme may be at work.

Type II inefficiency occurs in an auction that includes the right of first refusal. If the contractor with the right of refusal has the lower-level technology ex-post, then corruption can allow the contractor to bid high enough to have the opportunity to observe the opponent's bid and determine whether the opponent will be awarded the contract or not. Because the disadvantaged contractor will bid less aggressively than when he knows with certainty that a corruption scheme is in place, the advantaged contractor has more room to win the contract. Type II inefficiency occurs because the disadvantaged contractor takes cautionary measures, even when corruption does not occur.

4.2 Implications

We can interpret our findings by comparing bid function curves. When the advantaged contractor considers that the scheme is always practiced ($p=0$), he submits a bid any value, since he knows that it is going to be revised by the government. However, once the contractors perceive that the probability of a fair auction is strictly positive ($p>0$), the advantaged contractor faces the possibility that his bid will become public information without being revised by the government officials. Therefore, the advantaged contractor has to submit a meaningful bid that is greater than his cost c_A, but because there is still a positive probability that the corruption scheme will be implemented, he bids less aggressively than the disadvantaged bidder. In contrast, for the disadvantaged contractor, $p>0$ indicates weaker price competition than $p=0$. Thus, the disadvantaged contractor bids less aggressively than when $p=0$. However, because she knows that there is a strictly positive probability that the scheme will be implemented ($1-p>0$), the disadvantaged contractor bids more aggressively than the advantaged contractor. As a result, the bid function curves of both contractors are located above the 45-degree line, with the disadvantaged contractor's curve located below the advantaged contractor's bid function curve.

As the probability that the corruption scheme will be implemented increases, both contractors shift downwards, as demonstrated by the vertical differences between the advantaged and disadvantaged contractor bid function curves ceteris paribus. This movement of bid functions can be interpreted as follows. Let me restate my findings by adding the positive probability that the (promised) corruption scheme will not be executed.

1. When the procurement auction is fair ($p=1$) or perfectly corrupt ($p=0$), project allocation is not inefficient.
2. When the probability that the corruption scheme is not practiced becomes strictly positive ($p>0$), two possible types of inefficiencies emerge. One is achieved when the scheme is practiced, whereas the other is achieved when the scheme is not practiced.
3. As the probability that the corruption scheme will be implemented increases, the vertical differences between the advantaged and disadvantaged contractor bid function curves

increases, indicating that project allocation inefficiency can occur within a wider range of costs.

Keeping in mind that regulatory agencies detect and punish corruption because it creates unfair situations, the results presented here become quite interesting. When the government is perfectly corrupt and everybody in the economy knows so, there is no inefficient allocation, and projects are delivered with the lowest cost, although the convention itself is unfair. If a government prohibits bribes from contractors to the government, whether such plans are actually executed may depend on the detection level of the regulatory authorities. However, if the detection level is low, economic performance could be very low, meaning that inefficiency and higher project costs will more likely occur, even in an auction without corrupt arrangements. This provides a rationale for very stringent investigation procedures by third parties such as the FBI, which will presumably decrease to very close to zero the probability that corruption schemes will be carried out. This means that efficiency and reasonable project costs become more likely.

5 Conclusion

Although a great deal of literature has investigated the impact of variations in corruption schemes on the prices of contracts and the efficiency of contract allocation, these studies have not taken into account cases in which the probability that corruption schemes will not be practiced is strictly positive. In this paper, I introduced the idea of a government official who does not commit to implementing a corruption scheme in the context of sealed-bid, first-price procurement auction with identical type distribution and different utility functions. In such a situation, the advantaged contractor bids more aggressively than in a corrupt auction but less aggressively than in a fair auction. Alternatively, the disadvantaged contractor bids less aggressively than in a corrupt auction but more aggressively than in a fair auction. The implications of these different behaviors can be interpreted with respect to cautionary measures that can be taken in both situations. I have shown that because of differences in the certainty that corrupt plans will actually be executed; there can be two types of inefficiency in project allocation.

Note

1) Here I assume that λ is exogenously determined. Usually, the contractor does not necessarily report to the government official its true cost c_A. In some literature, λ is determined in a bargaining game to maximize the joint surplus of the advantaged bidder and the government officials. However, I do not focus on this aspect.

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