Keio Business School

Subcontractors' Behavior under Procurement Auctions

Questions

1. In the situation described in Subsection 1.1 of the text, each supplier decides on an estimate in anticipation of the estimates of the other competing suppliers in order to receive an order for the production of its part. Suppose that you are a supplier. Then, what estimate would you submit to the manufacturer for the cost of your own part production? Pay attention to the probability that you win and the profit when you win (the payment for the your from the manufacturer minus the the cost of your part production). (Hint: In Appendix 1, set five numerical values or more such as the cost of the part production of each supplier by yourself, and answer Q1 and Q3.)

2. In the situation described in Subsection 1.2 of the text, as a result of bid shopping, which supplier receives an order for part production and how much will be paid from Manufacturer 1? What is the relationship with the outcomes in the second-price reverse auctions shown in Appendix 2?

3. In the situation described in Subsection 1.2 of the text, does bid shopping increase the profit of Manufacturer 1?

4. In the situation described in Section 2 of the text, does bid shopping by manufacturers increase their profits? (Hint: In Appendix 1, set the numerical values such as the cost of part production for each supplier in Figure 1, and answer Q2 and Q4.)

5. Everlane is a D2C apparel company founded in San Francisco in 2010. It promises "radical transparency" and specifies the costs of every single piece of clothing made and sold, from materials, labor, transportation and taxes. Comment on Everlane's management policy, referring to your answers to the above questions.

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The aim of this case

In order to lower total costs, prime contractors often solicit estimates for part of their work from (potential) subcontractors who can perform that work (part production) on their behalf, prior to submitting their own estimates in procurement auctions. In this situation, the subcontractors behave as if they were bidding for the subcontract work in auctions conducted by the prime contractors. Estimates submitted by subcontractors are mostly kept private between the prime contractors and subcontractors. Recently, however, some procurement buyers require that the prime contractors reveal the prices of parts produced by subcontractors. We consider these transactions by some thought experiments.

1 Subcontract Auction: Suppliers

First, consider the following situation. Manufacturer 1 needs to purchase a part for its product and solicits estimates of the part from two suppliers. Suppose, for simplicity, that one unit of the part is to be traded here. Manufacturer 1 does not have sufficient knowledge on the technology for the part production and thus cannot produce it by itself. Each supplier knows the cost of its part production, but does not know the cost of the other supplier's. The quality of the part produced by the suppliers is indifferent, and thus Manufacturer 1 decides its order destination in reference only to the estimates suppliers submit. This transaction can be regarded as an auction, or we may say that it is a **subcontract auction**.

1.1 First-Price Reverse Auction

- In the subcontract auction described above, Manufacturer 1 makes an order of the part production to the lowest bidder (supplier which submits lowest estimate) and pays the amount the winner bids. This rule is called **first-price reverse auction**.
- There is not any types of cost which are related to this subcontract auction, and thus the loser earns no profit and incurs no loss.

Answer to Question 1.

1.2 Bid Shopping

- Suppose that a supplier, say Supplier 1, submitted a lowest estimate, as a result of the first price reserve auction.
- At this time, Manufacturer 1 may renegotiate with another supplier, Supplier 2, saying "We will order a part production if you deliver the part with a lower payment than the amount Supplier 1 submitted." Supplier 2 will accept this ex-post offer as far as the payment is greater than the production cost.

- Then, the winner of the first price reverse auction, Supplier 1, may also participate in the renegotiation, saying “We will deliver the part at a payment which is lower than that Supplier 2 accepted.”
- This price-cut renegotiation is called **bid shopping**. There is not any types of cost which are related to this bid shopping.
- Suppose that Manufacturer 1 makes an order of the part production to the lowest bidder and pays the amount the second lowest bids, i.e., a higher bid in the above situation. This rule is then called **second-price reverse auction**.

Answer to Questions 2 and 3.

2 Procurement Auction: Manufacturers

Second, consider the following situation. Manufacturer 1 is now faced with the situation described in Subsection 1.2. In a **procurement auction**, there is a competitor of Manufacturer 1, say Manufacturer 2, which solicits estimates of the part from two suppliers and decides the order destination and the payment via bid shopping, similarly to Manufacturer 1. The procurement buyer needs to purchase one unit of a product of manufacturers and determines the order destination and payment via first-price reverse auction. For each supplier, a supplier who wins a subcontract auction will not receive the actual order unless its manufacturer wins the procurement auction. For simplicity, suppose that manufacturers know their own production costs each other and that they are zero. Thus, the cost amounts the payment to a supplier when each manufacturer wins the procurement auction. There is not any types of cost which are related to this procurement auction, and thus the loser and its supplier earn no profit and incus no loss. In this situation, manufacturers are regarded as prime contractors (PCs) and suppliers are considered as subcontractors (SCs).

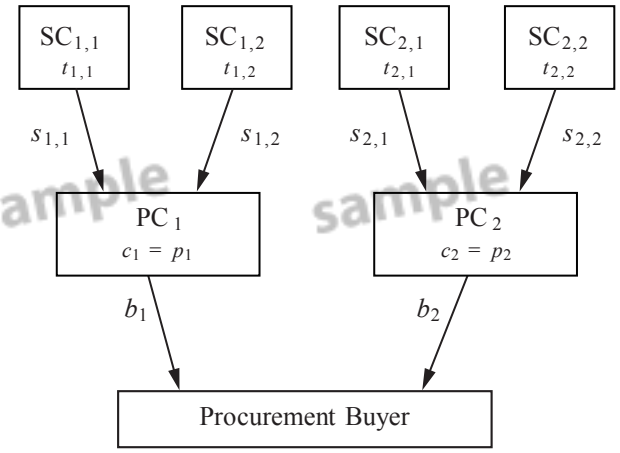

Figure 1: The whole structure of transactions

Figure 1 depicts the situation described above, where Manufacturer 1 and 2 are denoted by PC_1 and PC_2, respectively. The suppliers of Manufacturer i(= 1; 2) are denoted by $SC_{i,1}$ and $SC_{i.2}$. Let $t_{i,j}$ denote the $SC_{i,j}$'s cost of part production and let $s_{i,j}$ denote the estimate $SC_{i,j}$ submits to Manufacturer i. For Manufacturer i, there is no its own production cost, and thus the cost c_i is only the payment p_i to its supplier. Denote by b_i Manufacturer i's amount of bid.

Answer to Questions 4 and 5.

Appendix 1: Questionnaire

Suppose that a first-price reverse auction is conducted among suppliers (subcontractors) who compete for receiving an order of part production. Each supplier knows its own production cost which takes a value in the interval between 1000 and 2000. Every supplier does not know its rival's production costs, but it knows that the they are distributed between 1000 and 2000 with equal probability. In what follows, answer to questions drawing dice by yourself to determine your cost of part production.[1] In each of the following questions, generate a random number to determine the cost of your own part production for the supplier you are assigned to.

(Q1) You are supplier 1 of Manufacturer 1 and your cost of part production is _____ .

When you win against supplier 2, you receive an order of part production. How much amount of estimate do you submit to manufacturer 1?

Your estimate = _____ .

(Q2) You are supplier 1 of manufacturer 1 and your cost of part production is _____ .

Even if you win against supplier 2, you receive an order of part production only when manufacturer 1 wins against manufacturer 2 in the subsequent procurement auction. How much amount of estimate do you submit to manufacturer 1?

Your estimate = _____ .

(Q3) You are supplier 2 of Manufacturer 1 and your cost of part production is _____ .

When you win against supplier 1, you receive an order of part production. How much amount of estimate do you submit to manufacturer 1?

Your estimate = _____ .

[1] When you are divided into some groups and asked to answer those questions, suppose that for every supplier, the costs of part production are distributed over 1100, 1200, 1300, 1400, 1500, 1600, 1700, 1800, 1900 with equal probability. Namely, for each value of those, determine the estimate of your part production, knowing that the costs of the others' realize among those value with equal probability. Answer to the questions for each value which is given to you as the cost of your part production. The instructor of this case can conduct a classroom experiment by matching up some groups randomly.

(Q4) You are supplier 2 of Manufacturer 1 and your cost of part production is _____ .

Even if you win against supplier 1, you receive an order of part production only when manufacturer 1 wins against manufacturer 2 in the subsequent procurement auction. How much amount of estimate do you submit to manufacturer 1?

Your estimate = _____ .

3 Appendix 2: Reverse Auctions

The contents described here are found also in the Appendices of textbooks dealing with bidding that have been used in business schools. Although the description is somewhat technical, readers who are good at thinking analytically will find the following contents useful for developing a clearer understanding of the bidding behavior mentioned in the main text of this case material.

To begin, we will describe the situation to be analyzed with reference to the main text. A manufacturer planning to purchase one unit of a certain part asks two potential suppliers for their estimates. Here, for the sake of simplicity, let us assume that the transaction is made for a single unit of a part. The manufacturer has no knowledge of the technology required to make the part in question, and therefore is unable to produce the part in house. The cost of part production for each supplier is known only to that supplier. There is no readily discernable difference in quality between the parts produced by the different suppliers. Accordingly, the manufacturer will determine the supplier only with reference to the estimated price. No bidding fee is charged for the bidding itself. Suppose that both suppliers are risk-neutral.

First-Price Reverse Auction

In the above situation, let us suppose that the manufacturer orders production of the part from the supplier who submits the lowest estimate and that this supplier is paid according to that estimate. This rule for determining the supplier and payment amount is known as a **first-price reverse auction**.

As noted, each supplier knows the cost of its part production but does not know the cost of its rival supplier's one. However, each expects the other's cost to be distributed with equal probability between 0 and 1. Let us also suppose (for simplicity of calculation rather than as an essential assumption) that each supplier *i* expects that rival supplier *j* will be bidding at a price according to the following formula:

$$b_j = k_1 + k_2 c_j, \tag{1}$$

where k_1 and k_2 are constants, and c_j is the cost of part production of supplier *j*. Note also that we can ignore the possibility here that $c_i = c_j$, because the probability is negligibly small from the viewpoint of probability theory.

If supplier *i* enters a lower amount of bid than supplier *j*, i.e., $b_i < b_j$, then it will be able to take the order to produce the part. The winner is determined at random in the case of tie. Accordingly, because c_j is distributed with equal probability between 0 and 1, the probability of supplier taking the order is calculated as follows:

$$\text{Prob}(b_i < b_j) = \text{Prob}(b_i < k_1 + k_2 c_j) = \text{Prob}(\frac{b_i - k_1}{k_2} < c_j) = 1 - \frac{b_i - k_1}{k_2}.$$

Both suppliers are risk-neutral, and thus supplier i's expected payoff is expressed as

$$(1 - \frac{b_i - k_1}{k_2})(b_i - c_i). \tag{2}$$

The first-order condition for maximizing the expected payoff for supplier i is obtained by differentiating with respect to bi as

$$(1 - \frac{b_i - k_1}{k_2}) - \frac{b_i - c_i}{k_2} = 0 . \tag{3}$$

The second-order condition is also satisfied. Solving (3) for bi yields

$$b_i = (ci + k_1 + k_2)/2. \tag{4}$$

In a symmetric equilibrium, both suppliers will use the same bidding strategy, each attempting to maximize its expected payoff taking into account the bidding strategy of the other supplier.[2] In the equilibrium, supplier *j*'s expectation that supplier *i* obeys the bidding strategy $b_i = k_1 + k_2 c_i$ should be justified. Otherwise, supplier *j* could obtain a higher expected payoff by choosing a different bidding strategy. Therefore, the following relation must hold:

$$\frac{c_i + k_1 + k_2}{2} = k_1 + k_2 c_i. \tag{5}$$

[2] To be more precise, this equilibrium is called a symmetric Bayesian-Nash equilibrium.

It is easily seen that $k_2 = 1=2$ by looking at the coefficient of in (5). By substituting $k_2 = 1=2$ into (5), we have the following bidding function of supplier i in the symmetric equilibrium.

$$b_i = \frac{1}{2} + \frac{1}{2} c_i .$$

Second-Price Reverse Auction

Consider the situation described at the beginning of Appendix 2. At this time, let us assume that the manufacturer orders production of the part from the supplier who submitted the lowest estimate but that the price paid to the supplier is the lowest estimates provided by the suppliers who did not secure the order, i.e., the second-lowest of all of the estimates. This rule for determining the supplier and payment amount is called a **second-price reverse auction**. In the text of this case material, there are two suppliers and thus the second lowest estimate is the one the loser submitted, i.e., higher estimate among two estimates.

As previously, each supplier knows the cost of its part production but does not know the costs of its rival supplier's one. Again let us assume that each supplier expects the others' costs to be distributed with equal probability between 0 and 1. As we will now see, however, unlike in the case of the first-price reverse auction, this expectation is not the information each supplier requires for its best bidding strategy.

To anticipate our conclusion, in the case of second-price reverse auctions for orders of a single unit of a part, each supplier can maximize its expected payoff by bidding at the same level as the cost of its own part production. There is no benefit for each supplier to strategically misrepresent its cost. This property will be preserved regardless of the number of suppliers and irrespective of the other suppliers' costs of part production or what estimates they submit. The reasons for this are explained intuitively below. Note again that we can ignore the possibility here that $c_i = c_j$, because the probability is negligibly small from the viewpoint of probability theory.

(i) First, consider the case where a supplier submits an estimate that is higher than the cost of its own part production. When a given supplier wins, the amount paid to that supplier will be the lowest estimate submitted by the other. Denote this amount by $\hat{s}_2$. Now, if a supplier submitted an estimate that is higher than $\hat{s}_2$, then that supplier would lose. On the other hand, if a supplier submitted an estimate that is lower than $\hat{s}_2$, the supplier would earn a payoff equal to $\hat{s}_2$ minus its cost of its own part production. In other words, even when a supplier submits the estimate which is the same amount as the cost of its own part production,the probability of that supplier winning the bid does not change, and nor does the gain to be earned if that supplier wins. Therefore, even if a company makes a strategic misrepresentation by bidding with a bid price higher than its own component production cost, there is no prospect of an increase in that supplier's expected payoff.

(ii) Next, consider the case where a supplier submits an estimate that is lower than the cost of its own part production. When a given supplier wins, the payoff earned by that supplier is equal to $\hat{s}_2$ minus the cost of its own part production. Therefore, if $\hat{s}_2$ ends up being less than the cost, that supplier will end up suffering a negative payoff (i.e., a loss). This will never occur if the estimate is not lower than the cost. As mentioned in (i), as long as a company is the winner, the payoff earned by the supplier will always be the same.

(iii) According to (i) and (ii), for that supplier, there will be no benefit to making a strategic misrepresentation. The same can be said to be true for all other suppliers as well.