

Preferred Suppliers in Asymmetric Auction Markets

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Preferred Suppliers in Asymmetric Auction Markets

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Abstract

This paper examines preference in procurement with asymmetric suppliers. The preferred supplier has a *right-of-first-refusal* to obtain the contract at a price equal to the bid of a competing supplier. Despite the inefficiency created by the *right-of-first-refusal*, preference increases the joint surplus of the buyer and the preferred supplier. The buyer can increase his surplus by holding a pre-auction for the *right-of-first-refusal*. This is true even when the *ex ante* stronger supplier wins this pre-auction for preference.

Keywords: procurement auctions, vertical integration, bargaining solutions

JEL Classification: D44, D82, C79

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1. Introduction

In this paper, we examine preferred suppliers in procurement. Governments and corporations frequently have a preference for particular suppliers of various goods. Preference may arise in a variety of settings. First, preference for one supplier may arise from successful contractual relationships in the past between the buyer and this supplier. Second, preference for one supplier may also arise from the unique features of the goods or services provided by this supplier. Third, preference may arise from bribery of a buyer's procurement officer by the supplier.

In contrast to these explanations, the model of this paper will assume that the buyer explicitly creates preference for one of the suppliers. In particular, the buyer may grant preference to one supplier prior to procurement in return for some *ex ante* payment from the supplier. In practice, we envision that preference would be granted to one supplier for a specific period of time, covering multiple instances of purchases against different sets of competing suppliers during that time period.

Preference is modeled as a *right-of-first-refusal* for the preferred supplier. The *right-of-first-refusal* allows the preferred supplier to accept the contract at a price equal to the price offered by the competing supplier. The preferred supplier will clearly accept the contract whenever her cost is below that offer of the competing supplier. Thus, the competing supplier is bidding against the cost of the preferred supplier when he makes an offer to the buyer. This *right-of-first-refusal* affects the bidding behavior of the competing supplier, the allocation of the contract, the expected profits of the suppliers, the expected price paid by the buyer, the expected surplus of the buyer, and the expected joint surplus of the buyer and the preferred supplier.

Bikhchandani, Lippman, and Ryan (2005) examined the *right-of-first-refusal* in a symmetric sealed-bid second-price auction with one seller and many buyers. In the private-value setting, they find that the joint surplus of the seller and one buyer cannot be increased by granting a *right-of-first-refusal* to the buyer. With a second-price auction, the gain of the preferred buyer is equivalent to the loss of the seller because the competing buyers do not change their bidding behavior. Thus, they conclude that there is no incentive for the seller to grant or sell a *right-of-first-refusal* to one of the buyers.

In Burguet and Perry (2009), we examined the *right-of-first-refusal* in a symmetric private-value procurement model using two alternative auction designs for the one buyer and many suppliers. We first examine a sealed-bid first-price auction among the suppliers, and second, a modified open auction in which the winning supplier can make a final offer to the buyer. For each of these two auction designs, we find that the buyer and the preferred supplier can increase their joint surplus using a *right-of-first-refusal*.¹ When the competing suppliers bid more aggressively in the presence of a preferred supplier, the buyer and the preferred supplier can extract surplus from the competing suppliers. The inefficiency created by the *right-of-first-refusal* is more than offset by the expected profits extracted from the competing suppliers.

Both of these papers assume that the bidders (buyers or suppliers) are symmetric in that they have the same distributions of private values (values or costs). Lee (2008) and Thomas (2011) consider a private-value first-price procurement auction with two asymmetric suppliers. In Lee (2008), the suppliers have uniform cost distributions but with different lower bounds. He finds examples in which the buyer can increase his surplus by freely awarding a *right-of-first-refusal* to the *ex ante* weaker supplier. In these examples, the *right-of-first-refusal* to the weaker supplier can induce the stronger supplier to bid more aggressively, and this may result in a lower expected price paid by the buyer. In Thomas (2011), the suppliers draw costs from different distributions within a modified Beta family of cost distributions.² He finds examples in which a merger reduces the joint surplus of the buyer and the internal supplier with a *right-of-first-refusal*. In these cases, the buyer and this supplier would not negotiate for the sale of a *right-of-first-refusal*.

For both papers, the first-price auction with asymmetric suppliers makes it difficult to obtain any general conclusions about freely-awarding a *right-of-first-refusal*. In contrast, we examine the *right-of-first-refusal* in a procurement model with asymmetric suppliers where the reference point is an open auction, instead of a first-price auction. That is, we model procurement as an open process where the buyer sequentially contacts suppliers in search for the best offers. By doing so, we can examine general cost distributions over the same interval, subject only to a standard condition which guarantees a monotonic bidding function for the

¹ See also Choi (2009).

² For certain parameters, the Beta family of cost distributions is not ordered according to first order stochastic dominance, and the inverse hazard rate is not monotonic.

competing supplier in the preference auction. The stronger supplier has a cost distribution that stochastically dominates the cost distribution of the weaker supplier.

More importantly, we also allow the buyer to sell the *right-of-first-refusal* in a pre-auction. The buyer could benefit from freely awarding the *right-of-first-refusal* to one of the suppliers if the other supplier bids sufficiently more aggressively to compensate for the lost competition from the preferred supplier. But this circumstance need not occur, and may be much less likely. Thus, it is important to examine a pre-auction for the sale of the *right-of-first-refusal*.

With an open auction as the reference point, we show that the buyer can always benefit by holding a pre-auction for the *right-of-first-refusal*, in effect, selling preference to one of the suppliers. In the pre-auction for preference, the buyer awards the *right-of-first-refusal* to the supplier which generates the lowest net expected price, defined as the expected price in the resulting preference auction minus the payment received from the preferred supplier for the *right-of-first-refusal*. The willingness to pay for preference of each supplier equals the sum of the gain from being the preferred supplier with the *right-of-first-refusal* and the loss from being the competing supplier without it. Even though awarding the *right-of-first-refusal* to either supplier induces an inefficiency, the payment received by the buyer in the pre-auction for preference more than compensates for this inefficiency and any increase in the surplus of the preferred supplier.

The pre-auction for preference benefits the buyer even though the stronger supplier may win the pre-auction for preference. Thus, the pre-auction does not necessarily have the effect of strengthening the weaker supplier against the stronger supplier. Indeed, it may be more likely for the stronger supplier to be the winner of the pre-auction. In particular, we find that the winner of the pre-auction is the supplier that generates the lower total cost of procurement and thus the lower inefficiency from awarding preference.

Finally, we also show that the joint surplus of the buyer and the preferred supplier is always higher than it would have been when the two suppliers compete in an open auction without preference for either. This result is true for both the weaker and stronger supplier. Thus, the buyer will always be able to reach a mutually profitable agreement with either supplier for the sale of the *right-of-first-refusal*.

The paper is organized as follows. In Section 2, we present the procurement auction with and without preference. In Section 3, we define the pre-auction for preference and explain its

properties. In Section 4, we show that the pre-auction always benefits the buyer. We also show that preference is mutually profitable. Thus, even if the buyer can negotiate with only one supplier, it will be in their mutual interest to create a *right-of-first-refusal*. In Section 5, we solve the model for the family of Pareto cost distributions and show that, for this family of distributions, the stronger supplier always wins the pre-auction for preference. Section 6 summarizes the results and discusses the remaining open questions. The proofs are contained in the Appendices.

2. Procurement Auction with and without Preference

The buyer has a value v for a good with a fixed quantity and quality. There are two suppliers with independent cost distributions for producing the good. We assume that each supplier draws his/her cost of production c_i , as an independent realization of a cost distribution $G_i(c)$ with the support $[0,1]$, and a continuous density function $g_i(c)$ over this support. The cost c_i is private information for each supplier. We assume that these distributions can be ordered in terms of first-order stochastic dominance: $G_1(c) \geq G_2(c)$ for all c . In other words, the stronger supplier 1 has a more favorable cost distribution than the weaker supplier 2. In addition, we will confine our attention to cost distributions for which the *virtual cost*, $c - [1 - G_i(c)]/g_i(c)$, is increasing in c . This is guaranteed if the inverse hazard rate (the second term) is decreasing in c . This assumption on the cost distributions is sufficient for bidding functions in the preference auction to be monotonically increasing in c . Finally, we also assume that the value of the buyer exceeds the highest possible cost realization ($v > 1$).

The buyer could organize procurement without preference by inviting offers and improvements on existing offers. We model this as an *efficient auction* (EA) in the form of a descending-price open auction. If so, the contract would be awarded to the supplier with the lowest cost at a price equal to the second lowest cost.³ Alternatively, the buyer may award a *right-of-first-refusal* (ROFR) to one of the suppliers, called the *preferred supplier* (PS). After

³ In particular, we assume that the buyer cannot set a reserve price for the procurement auction. More generally, we assume that the buyer cannot commit to the rules for the auction in the procurement stage, but can only receive price offers from the suppliers. An open auction allows the buyer to receive sequentially decreasing price offers from the suppliers. When preference is awarded, there is only one supplier, the competing supplier, from whom the buyer may obtain offers before turning to the preferred supplier.

receiving a final bid for the contract from the other *competing supplier* (CS), the buyer then offers the contract to the PS at a price equal to the bid of the CS.⁴ We call this a *preference auction*. The contract will be accepted by the PS if her cost is below the bid of the CS, and rejected by the PS otherwise.⁵ If the contract is rejected by the PS, then the contract is awarded to the CS at a price equal to his bid. In sum, *preference* means that the PS has a *ROFR* at the bid of the CS.

The timing of the game is as follows. At stage 1, the preference for one supplier is determined prior to the realization of the costs of the suppliers. At stage 2, the suppliers privately learn their costs, and then at stage 3, the procurement auction occurs. At this stage 3, we assume that each supplier knows whether the other supplier is a preferred supplier or not. If no preference was granted to either supplier at stage 1, the procurement auction is a descending-price open auction with both suppliers participating. If preference was granted to one of the suppliers at stage 1, the procurement auction becomes a preference auction.

Consider first the procurement auction without preference. The expected price paid by the buyer in stage 3 is simply the expected higher cost of the two suppliers. We can also express this expected price as the sum of the expected cost plus the expected profits of the two suppliers:

$$(1) \quad EP_{EA} = EC_{EA} + E\Pi_1 + E\Pi_2 ,$$

The expected surplus of the buyer at stage 1 would simply be $v - EP_{EA}$. The expected cost is the expected lower cost of the two suppliers:

$$(2) \quad EC_{EA} = \int_0^1 c \cdot [g_i(c) \cdot (1 - G_j(c)) + g_j(c) \cdot (1 - G_i(c))] \cdot dc .$$

Using standard derivations, we can write the expected profit of the i^{th} supplier at stage 2 with a cost realization c as:

$$(3) \quad \Pi_i(c) = \int_c^1 [1 - G_j(x)] \cdot dx .$$

After integrating over its cost distribution and changing the order of integration, the expected profit of the i^{th} supplier at stage 1 is:

⁴ We assume that the bid of the CS is verifiable. For example, the buyer can show the PS a signed document with the bid of the CS.

⁵ With the *ROFR*, the PS would not bid against the CS because doing so would only lower the expected price he would receive. If the PS submitted a bid below the bid of the CS, his bid would be lower than the price he would receive by exercising his *ROFR*. Of course, this assumes that any *ex ante* payment for the *ROFR* is independent of any bid that the PS might make in the procurement auction.

$$(4) \quad E\Pi_i = \int_0^1 G_i(c) \cdot [1 - G_j(c)] \cdot dc .$$

The expected surplus of the buyer, $v - EP_{EA}$, and the expected profits of the suppliers without preference will serve at the reference point for evaluating the benefits from awarding of preference.

Now consider the procurement auction in which preference is awarded to one of the suppliers at stage 1. The preference auction in stage 3 is a simple open auction in which the CS makes a price offer to the buyer in an attempt to bid below the cost of the PS. The buyer then reveals the offer to the PS who then exercises her *ROFR* and decides whether to accept the contract at a price equal to that offer. Since either of the two suppliers may be the PS, we will use the subscript “*p*” to denote variables corresponding to the PS and the subscript “*k*” to denote variables related to the CS. We now characterize the bidding function of the CS when the j^{th} supplier is the CS and the i^{th} supplier is the PS. This bidding function $b_j(c)$ is the solution to the following maximization problem:

$$(5) \quad b_j(c) = \arg \max_b \Pi_{k=j}(b, c) = \arg \max_b (b - c) \cdot [1 - G_i(b)] ,$$

where $\Pi_{k=j}(b, c)$ denotes the expected profits of the j^{th} supplier as the CS when his cost is c and his bid is b . The assumption of an increasing virtual cost is sufficient to guarantee that the unique solution to (5) is increasing in c and that the second order conditions are satisfied. Thus, the CS has a unique monotonically-increasing optimal bidding function. This bidding function $b_j(c)$ is implicitly defined by the following condition:

$$(6) \quad b_j - c = \frac{1 - G_i(b_j)}{g_i(b_j)} ,$$

for which $b_j(0) > 0$ and $b_j(1) = 1$.⁶ This bidding function of the CS is the best *take-it-or-leave-it* final offer by the j^{th} supplier to the buyer who has granted a *ROFR* to the i^{th} supplier.

The price paid by the buyer in stage 3 is equal to the bid of the CS, irrespective of which supplier is awarded the contract. If the j^{th} supplier is the CS, the expected price at stage 1 is

⁶ The implicit definition of the bidding function in (6) is obtained by rearranging the first-order condition to the maximization problem in (5).

$$(7) \quad EP_{p=i} = \int_0^1 b_j(c) \cdot g_j(c) \cdot dc \ .$$

Since the bidding function $b_j(c)$ of the CS depends on the cost distribution $G_i(c)$ of the PS, this expected price depends on both cost distributions. In general, the expected price will differ depending on which supplier is the CS.

This preference auction introduces an inefficiency that is not present in the open auction without preference. For cost realizations such that $c_j < c_i < b_j(c_j)$, the j^{th} CS has a lower cost, but the contract is awarded to the i^{th} PS at a price equal to $b_j(c_j)$. When the i^{th} supplier is the PS, the expected value of this inefficiency is an opportunity cost of any mechanism that creates a *ROFR* for the i^{th} supplier:

$$(8) \quad IE_{p=i} = \int_0^1 \int_c^{b_j(c)} (x - c) \cdot g_i(x) \cdot dx \cdot g_j(c) \cdot dc \ .$$

With this inefficiency, the expected cost of the suppliers in the preference auction in which the i^{th} supplier is the PS can be expressed as

$$(9) \quad EC_{p=i} = EC_{EA} + IE_{p=i} \ .$$

This expected cost is clearly higher than the expected cost in an efficient open auction without preference.

We can now define the expected profits of both the CS and PS in the preference auction. Consider the i^{th} supplier, first as the CS, then as the PS. With a differentiable monotone bidding function $b_i(c)$, incentive compatibility requires that the derivative of the expected profits $\Pi_{k=i}(c)$ of the CS with respect to cost c satisfies:

$$(10) \quad \frac{d\Pi_{k=i}(c)}{dc} = -[1 - G_j(b_i(c))] \ .$$

After integrating, we obtain the expected profit function of the i^{th} CS at stage 2 with the cost c :

$$(11) \quad \Pi_{k=i}(c) = \int_c^1 [1 - G_j(b_i(x))] \cdot dx \ .$$

Instead, if the i^{th} supplier is the PS, the expected profits $\Pi_{p=i}(c)$ with a cost c , facing a bidding function $b_j(x)$ of the CS, can be expressed as

$$(12) \quad \Pi_{p=i}(c) = \int_{b_j^{-1}(c)}^1 (b_j(x) - c) \cdot g_j(x) \cdot dx \quad \text{for } c > b_j(0) \ .$$

After integrating by parts, performing a change of variables, and including the trivial modification when $c \leq b_j(0)$, we obtain the expected profit function of the i^{th} PS at stage 2 with the cost c :

$$(13) \quad \Pi_{p=i}(c) = \begin{cases} \int_c^1 [1 - G_j(b_j^{-1}(x))] \cdot dx & \text{if } c > b_j(0) \\ (b_j(0) - c) + \int_{b_j(0)}^1 [1 - G_j(b_j^{-1}(x))] \cdot dx & \text{if } c \leq b_j(0) \end{cases}$$

After integrating expressions (12) and (13) over the cost distribution of the i^{th} supplier, the expected profits of i^{th} supplier as either the CS or the PS can be expressed as:

$$(14) \quad E\Pi_{k=i} = \int_0^1 G_i(c) \cdot [1 - G_j(b_i(c))] \cdot dc ,$$

$$(15) \quad E\Pi_{p=i} = \int_0^{b_j(0)} G_i(c) \cdot dc + \int_{b_j(0)}^1 G_i(c) \cdot [1 - G_j(b_j^{-1}(c))] \cdot dc .$$

Expressions (14) and (15) are the expected profits after the i^{th} supplier knows whether it is the CS or the PS from stage 1, but before the i^{th} supplier knows his cost in stage 2. The expressions for the j^{th} supplier are obtained by simply reversing the subscripts.

3. The Pre-Auction for Preference

Relative to the expected profits in an efficient auction from (4), it is straight-forward to verify that either supplier would benefit from being the PS and would be harmed as the CS:

$$(16) \quad E\Pi_{p=i} > E\Pi_i > E\Pi_{k=i} .^7$$

As a result, either supplier would be willing to pay some amount at stage 1 in order to become the PS and to avoid being the CS. The willingness to pay for preference is equal to the difference between the higher expected profits with preference and the lower expected profits without preference:

$$(17) \quad V_{p=i} = E\Pi_{p=i} - E\Pi_{k=i} .$$

⁷ This second inequality that $E\Pi_i > E\Pi_{k=i}$ follows from the fact that $b_i(0) > c$ for $c < 1$. Similarly, the first inequality that $E\Pi_{p=i} > E\Pi_i$ follows from the fact that $b_j^{-1}(c) < c$ for $c < 1$.

One part of this willingness to pay arises from the advantage of being the PS, $EII_{p=i} > EII_i$, but the other part derives from the disadvantage of competing against a PS, $EII_i > EII_{k=i}$. Overall, $V_{p=i}$ is the highest offer that the i^{th} supplier would make or match in the pre-auction for preference.

We now define a pre-auction for preference by which the buyer awards the *ROFR* to one of the suppliers. Consistent with the way we modeled the open and preference auctions at stage 3, we model the pre-auction for preference as an ascending-price open auction.⁸ The buyer invites offers for preference and accepts the offer that results in the lower net expected price that he pays for the good. If the i^{th} supplier wins the pre-auction at a price of $R_{p=i}$ for the *ROFR*, the net expected price paid by the buyer would then be

$$(18) \quad NEP_{p=i} = EP_{p=i} - R_{p=i} .$$

In effect, the price for preference in stage 1 offsets part of the potentially higher expected price paid in the preference auction during stage 2. Similar to (1), we can express $EP_{p=i}$ as:

$$(19) \quad EP_{p=i} = EC_{p=i} + EII_{p=i} + EII_{k=j},$$

where $EC_{p=i}$ is the expected cost of procurement when the i^{th} supplier is the PS.

If the expected price in the preference auction $EP_{p=i}$ were independent of which supplier was the PS, then the pre-auction in stage 1 could be a simple open auction in which the buyer awarded the *ROFR* to the supplier with the higher willingness to pay for preference at a price equal to the lower willingness to pay of the other supplier. For example, if $V_{p=1} > V_{p=2}$, then $R_{p=1} = V_{p=2}$. This case would obviously occur if the suppliers were symmetric with the same cost distribution as in Burguet and Perry (2009). This case would also occur if the cost distributions of the asymmetric suppliers are both members of the Pareto family of distributions. This case is discussed in Section 5.

In general, the expected price in the preference auction would differ depending on which supplier is awarded the *ROFR*. As a result, the buyer would accept a lower offer for the *ROFR* from one supplier if awarding the *ROFR* to the other supplier would result in a higher expected price in the preference auction. We can now define the pre-auction for preference taking account

of the differences in the expected prices from the preference auction. Let $D = EP_{p=1} - EP_{p=2}$, and call this the expected price differential. Note that this number may be negative. The buyer would prefer to accept the offer of supplier 2 unless supplier 1 offers a price that is D higher than the price offered by supplier 2. Thus, the best standing offer is the offer from supplier 1 if it exceeds the offer from supplier 2 by the amount D . Otherwise, the best standing offer is the offer from supplier 2. The suppliers will increase their offers only up to their willingness to pay $V_{p=i}$. Thus, supplier 2 will drop out of the pre-auction if supplier 1 bids above $V_{p=2} + D$, while supplier 1 would drop out of the pre-auction if supplier 2 bids above $V_{p=1} - D$. Thus, in equilibrium, supplier 1 wins the pre-auction if

$$(20) \quad V_{p=1} \geq V_{p=2} + D,$$

and pays $R_{p=1} = V_{p=2} + D$ for the *ROFR*. Otherwise, supplier 2 wins the pre-auction and pays $R_{p=2} = V_{p=1} - D$ for the *ROFR*. Condition (20) implies the following result.

Proposition 1: The supplier which makes the winning offer in the pre-auction for preference is the supplier which generates the lower total cost of procurement after preference is awarded and thus the lower inefficiency from preference. (See Appendix 1 for the proof.)

As we will see in Section 5, the supplier who wins the pre-auction for preference need not be the weaker supplier. Indeed, it may be more likely that the stronger supplier would win the pre-auction.

4. The Effects of the Pre-Auction for Preference

We now investigate whether the buyer benefits from having the pre-auction for preference. In particular, we ask whether the net expected price after the pre-auction is lower than the expected price from holding an efficient auction without preference for either supplier. If the i^{th} supplier wins the pre-auction, we ask whether: $NEP_{p=i} < EP_{EA}$. Substituting the

⁸ At this stage, there is no asymmetry of information between the buyer and the sellers. Thus, the equilibrium of the pre-auction is the same for an open or a sealed bid auction.

winning prices paid for the *ROFR* by either winning supplier 1, $R_{p=1} = V_{p=2} + D$, or winning supplier 2, $R_{p=2} = V_{p=1} - D$, into expression (18) for the net expected price, we find that the winning net expected price can be expressed as

$$(21) \quad NEP_{p=i} = EP_{p=j} - V_{p=j} .$$

Note that the winning offer in the pre-auction results in an index reversal from the original expression in (18). However, the intuition follows immediately by substituting for the expected price from (19) and the willingness to pay from (17). The resulting winning net expected price is

$$(22) \quad NEP_{p=i} = EC_{p=j} + E\Pi_{k=1} + E\Pi_{k=2},$$

where $EC_{p=j}$ is the expected cost of procurement if the non-winning supplier had been awarded the *ROFR* at stage 1.

According to Proposition 1, if the i^{th} supplier wins the pre-auction for preference, then $EC_{p=j} - EC_{p=i} \geq 0$. Thus, if suppliers are symmetric, by selling preference, the buyer extracts the suppliers' profits above their profits as a competing supplier. When suppliers are not symmetric, the winning supplier i will retain expected profits $EC_{p=j} - EC_{p=i}$ above that level of profits as competing supplier. This observation will be important to explain our main results below.

If $EC_{p=i} = EC_{EA}$, this would immediately mean that selling preference is in the buyer's interest, because $E\Pi_{k=i} < E\Pi_i$. However, preference introduces an inefficiency, and so $EC_{p=i} > EC_{EA}$.

The next proposition states that this inefficiency is always more than compensated by the extraction of sellers' profits. . This generalizes the result in Burguet and Perry (2009) for two asymmetric.

Proposition 2: The net expected price paid by the buyer is always lower with a pre-auction for preference than with an efficient auction. (See Appendix 1 for the proof.)

Proposition 2 makes it clear that the combined surplus of the suppliers is lower with the pre-auction for preference, and that the resulting surplus extraction by the buyer at stage 1 always dominates the resulting inefficiency created in the preference auction at stage 3.

With asymmetric suppliers, it is well understood that the buyer can benefit by favoring the weaker supplier. However, Proposition 2 implies that the buyer will benefit from a pre-auction for preference even when the *ex ante* stronger supplier wins the pre-auction. Indeed, this may be the typical case. In section 5, we will discuss a family of cost distributions for which the stronger supplier always wins the pre-auction for preference, but yet the buyer always benefits as stated in Proposition 2.

We now provide some intuition for Proposition 2. Assume that supplier 1 wins the pre-auction for preference, and consider the expression for the winning net expected price from (17). Now, consider any given value of c_2 . We may compute the realized combined value of the three terms in (22) for any value of c_1 . First, if $c_1 < b_1^{-1}(c_2)$, the cost when supplier 2 is the PS is c_1 , the profit for supplier 1 as the CS is $b_1(c_1) - c_1$, and the profit for supplier 2 as the CS is 0. Thus, the combined value is $b_1(c_1)$. Second, if $b_1^{-1}(c_2) < c_1 < b_2(c_2)$, the cost when supplier 2 is the PS is c_2 , and the profit for both suppliers as the CS is 0. Thus, the combined value is c_2 . Finally, if $b_2(c_2) < c_1$, the cost when supplier 2 is the PS is c_2 , the profit of supplier 1 as the CS is 0, and the profit of supplier 2 as the CS is $b_2(c_2) - c_2$. Thus, the combined value is $b_2(c_2)$. In Figure 1, these three cases correspond, respectively, to the intervals $(0,a)$, (a,e) , and $(e,1)$.

Let us now consider the expected price when the buyer does not sell preference. Here we will invoke the revenue equivalence theorem. Consider a different efficient auction where supplier 1 received a deterministic price $B_1(c_1) = E[c_2 | c_2 \geq c_1]$ when winning (i.e., when $c_1 \leq c_2$) and supplier 2 received $B_2(c_2) = E[c_1 | c_1 > c_2]$ when winning. Such an auction would result in the same expected price for the buyer and the same expected profits for the sellers. We use this auction to compare with the net expected price with preference. Given the same value of c_2 , we may compute the expected price for each realization of c_1 as $B_1(c_1)$ when $c_1 < c_2$ and $B_2(c_2)$ when $c_1 \geq c_2$. These two cases correspond to the intervals $(0,d)$ and $(d,1)$ in Figure 1. Thus, there are four regions to compare: $(0,a)$, (a,d) , (d,e) , and $(e,1)$. For $(0,a)$, the net expected price would be $b_1(c_1)$ above, while in the efficient auction it is $B_1(c_1)$. For (a,d) , the net expected price

would be c_2 above, while in the efficient auction it is $B_1(c_1)$. For (d,e) , the net expected price would be c_2 above, while in the efficient auction it is $B_2(c_2)$. Finally, for $(e,1)$, the net expected price would be $b_2(c_2)$ above, and $B_2(c_2)$ in the efficient auction. Note that for any value of c_1 above a , $c_2 < b_1(c_1)$. This illustrates the result if $b_i(c_i) \leq B_i(c_i)$, i.e., if the competing supplier under preference bids more aggressively than in the efficient auction.⁹ The proposition shows that this is also the case even when the competing supplier bids less aggressively under preference.

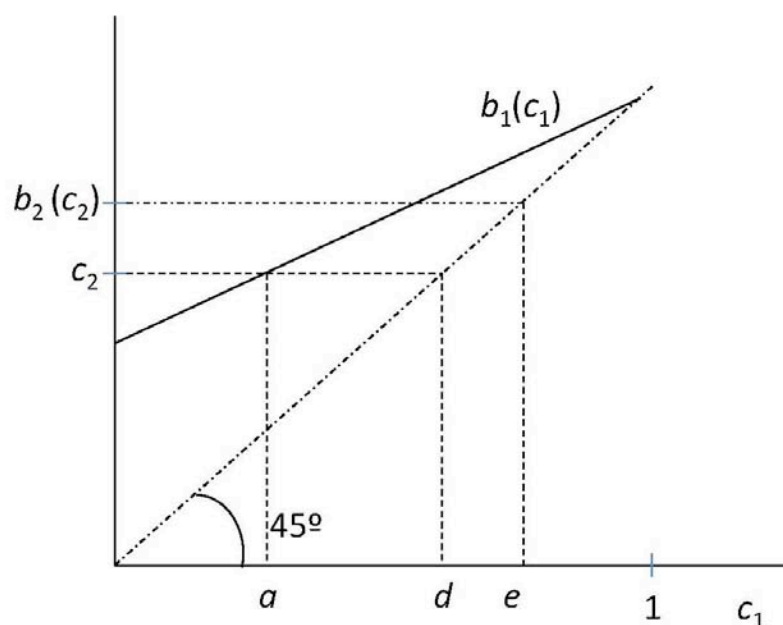


Figure 1

The pre-auction for preference is just one method by which the buyer could award a *ROFR* to one of the suppliers. In particular, the pre-auction involves competition between the suppliers for preference. The following proposition reinforces this finding by showing that the buyer and either supplier can mutually benefit from bilateral negotiations for the award of a *ROFR*.

⁹ Although for the symmetric case, Arozamena and Weichelbaum (2009) have shown that log-concavity of the distributions of costs is sufficient for this to be the case. It is a simple exercise to extend that result to the present, asymmetric model.

Proposition 3: If the *right-of-first-refusal* is awarded to either supplier, the joint surplus of the buyer and that preferred supplier is higher than their joint surplus in an efficient auction without preference. (See Appendix 1 for the proof.)

In any negotiation between the buyer and either supplier, for example supplier 1 at stage 1, the buyer always has the option to not award the *ROFR* and to hold an efficient open auction. Thus, the disagreement payoff of the buyer is the expected surplus $v - EP_{EA}$ in an efficient auction. Assuming that the buyer cannot negotiate with supplier 2, the disagreement point of supplier 1 is EII_1 . Proposition 3 states that the buyer can reach a mutually beneficial agreement for the sale of the *ROFR* to supplier 1, even without the corresponding ability to negotiate with supplier 2.

5. Pareto Family of Cost Distributions

In this section, we identify a family of cost distributions in which neither supplier bids more or less aggressively as a competing supplier in the preference auction than they would in an efficient auction. As a result of the elimination of competition, the expected price in the preference auction must be higher than the efficient auction, and the buyer would not benefit from freely-awarding the *ROFR* to either supplier. When the buyer then holds a pre-auction to sell the *ROFR*, the stronger supplier always wins the pre-auction. Despite this, Proposition 2 implies that the net expected price is lower than the expected price in the efficient auction. The pre-auction allows the buyer to extract surplus from the winning supplier, and this surplus extraction dominates the inefficiency created in favor of the stronger preferred supplier in the preference auction.

The Pareto family of cost distribution functions can be defined as $G(c;t) = 1 - (1 - c)^t$ over the support $[0,1]$ where c is the cost and $t > 0$ is a parameter which can differ for the two suppliers. The corresponding density function is $g(c;t) = t \cdot (1 - c)^{t-1}$. This density function is everywhere increasing when $t < 1$, everywhere decreasing when $t > 1$, and uniform when $t = 1$. The parameter t ranks the cost distributions within the family by first-order stochastic dominance. Assume that the first supplier is the stronger supplier, i.e. $t_1 > t_2$. First-order

stochastic dominance means that $G(c; t_1) > G(c; t_2)$ for all c in the support. The inverse hazard rate function, $H(c) = [1 - G(c; t)] / g(c; t)$, is linearly decreasing in c . This implies that the virtual cost is increasing in c and so the first-order condition for the bidding function from the maximization problem (5) has a monotone solution in the cost c . The resulting bidding function of the CS obtained from (6) has the following convenient linear form:

$$(23) \quad b_j(c) = \frac{1}{1+t_i} + \frac{t_i}{1+t_i} \cdot c .$$

The CS bids more aggressively when the PS is stronger.

In order to compare the aggressiveness of the CS in a preference auction with that in an efficient auction, consider the *implicit bidding function* for each supplier in the efficient auction without preference. As in the previous section, we can define this implicit bidding function for the j^{th} supplier as the expected price paid by the buyer to the j^{th} supplier when the j^{th} supplier wins the auction with a cost c . In the efficient auction, this is equal to the expected value of c_i conditional on being above c . That is:

$$(24) \quad b_{EA,j}(c) = E[c_i | c_i \geq c] = \frac{\int_c^1 x \cdot g(x; t_i) \cdot dx}{1 - G(c; t_i)} = \frac{1}{1+t_i} + \frac{t_i}{1+t_i} \cdot c .$$

Thus, the bidding function of the CS in the preference auction is identical to this implicit bidding function in an efficient auction. As a result, preference for the PS does not induce the CS to bid more or less aggressively than he would in an efficient auction.

Using (7), we also find that the expected price in the preference auction is independent of whether the stronger or weaker supplier is the preferred supplier:

$$(25) \quad EP_{p=1} = EP_{p=2} = \frac{1+t_1+t_2}{(1+t_1)(1+t_2)} .$$

When the CS is the weaker supplier, he has a lower probability of obtaining a low cost, but he bids more aggressively. On the other hand, when the CS is the stronger supplier, he has a higher probability of obtaining a low cost, but he bids less aggressively. With the Pareto family of cost distributions, these two forces exactly offset each other and the expected price in the preference auction is the same irrespective of which supplier is preferred, and $D = 0$.

We can now compare the expected price in the preference auction to the expected price that would arise with an efficient auction:

$$(26) \quad EP_{EA} = \frac{1+t_1+t_2}{(1+t_1)(1+t_2)} - \frac{t_1 \cdot t_2}{(1+t_1)(1+t_2)(1+t_1+t_2)}.$$

Comparing expressions (25) and (26), we see that the common expected price in a preference auction is always higher than the expected price in an efficient auction: $EP_{p=1} = EP_{p=2} > EP_{EA}$ for all $t_1 \geq t_2$. Since the CS does not bid more or less aggressively than he would in an efficient auction without preference, the expected price in the preference auction must be higher without the competition of the PS.

More importantly, with the Pareto family, we find that the stronger supplier always wins the pre-auction for preference. Indeed, we can compute

$$(27) \quad E\Pi_{p=i} = \frac{t_i}{(1+t_i) \cdot (1+t_j)} + \frac{t_i \cdot t_j}{(1+t_i)^2 \cdot (1+t_i+t_j)} \cdot \left(\frac{t_i}{1+t_i} \right)^{t_i}, \text{ and}$$

$$(28) \quad E\Pi_{k=i} = \frac{t_i}{(1+t_j) \cdot (1+t_i+t_j)} \cdot \left(\frac{t_j}{1+t_j} \right)^{t_j}$$

for this case. In Appendix 2, we show that $V_{p=1} > V_{p=2}$ whenever $t_1 > t_2$. Thus, for this family of cost distributions, the stronger supplier wins the pre-auction for preference. In addition, we can show that the expected profits of the stronger PS are less than what her expected profits would have been in the efficient auction without preference. Thus, auctioning preference allows the buyer to extract surplus from both suppliers. Since $D = 0$, the net expected price is simply $NEP_{p=1} = EP_{p=2} - V_{p=2}$. Proposition 2 implies that this net expected price is lower than the expected price in the efficient auction.

6. Conclusions

The pre-auction for preference clearly empowers the buyer relative to holding an efficient auction at the procurement stage. In particular, the buyer can extract surplus from the suppliers because part of the willingness to pay for preference arises from the reduction in expected profits if the other supplier is preferred instead. Indeed, the benefit to the buyer from

the pre-auction for preference arises solely from surplus extraction, and not from the creation of any new efficiencies. The standard justification for exclusive dealing contracts (Marvel, 1982) is that the interests of the buyer and the supplier will be more closely aligned, and that various efficiencies would arise from eliminating externalities in the production and distribution decisions. fOn the contrary, the benefit to the buyer from the preference auction arises precisely because preference creates an allocative distortion in the award of the procurement contract. The buyer then takes advantage of this distortion by extracting surplus in the pre-auction for preference or in negotiations with one supplier.

One of the interesting findings is that the stronger supplier will often win the pre-auction for preference. Thus, the initial cost disadvantage of the weaker supplier is exacerbated by the pre-auction, making the competitive environment even less favorable for the weaker supplier.

There are several open questions that this paper has not addressed. We are modestly confident that these questions will not have general answers, but the family of cost distributions in section 5 does not provide any counter examples. One open question is whether, in the context of open efficient auctions there are broad classes of cost distributions in which preference would induce the competing supplier to bid sufficiently more aggressively that the expected price in the preference auction would actually be lower than the expected price in the efficient auction. If so, the buyer could benefit by freely-awarding the *ROFR*, and this would complement the examples in Lee (2008). We believe that such classes of cost distributions will exist. A second open question is whether there are broad classes of cost distributions in which the weaker supplier would win the pre-auction for preference. If the stronger supplier always won the pre-auction, that finding would support the conclusion that surplus extraction will disfavor the weaker supplier, contrary to the traditional auction insight that a buyer would wish to favor the weaker supplier. We cannot prove that the stronger supplier will always win the pre-auction, but we believe that this will be the typical case. A third open question is whether the preferred supplier can always benefit from the pre-auction for preference. If so, the supplier who would win the pre-auction, such as the stronger supplier, would make unsolicited offers to the buyer for the *ROFR*. Proposition 3 makes it clear that the joint surplus of the buyer and either supplier would be higher, but the pre-auction provides the buyer with the additional power to extract rents from both suppliers.

Within the context of a first-price sealed-bid auction, the open question is whether the Propositions here generalize to that alternative reference point. The results in Thomas (2011) indicate that Proposition 3 would not generalize to first-price auctions. Waehrer (1999) showed that the profitability of a vertical merger was lower when the buyer used a first-price auction instead of an open auction or second-price auction. The examples where mergers are not profitable in Thomas (2011) appear to be ones for which the pre-merger market share of the merged supplier is less than 50%. If so, the buyer is merging with the weaker supplier. If so, preference for the merging weaker supplier will reinforce the existing favoritism that arises naturally from the fact that the weaker supplier bids more aggressively than the stronger supplier in the first-price auction. A more interesting open question is whether Proposition 2 would generalize so that the pre-auction for preference would always benefit the buyer. One issue is whether the first-price auction attenuates the ability of the buyer to extract surplus from the suppliers with the pre-auction. We have no intuition why it would, but we have not been able to prove a result corresponding to Proposition 2 for first-price auctions.

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Appendix 1: Proofs of the Propositions

Proposition 1:

Supplier 1 will win the pre-auction if and only if

$$V_{p=1} \geq V_{p=2} + D \geq 0 \Leftrightarrow (E\Pi_{p=1} - E\Pi_{k=1}) - (E\Pi_{p=2} - E\Pi_{k=2}) - (EP_{p=1} - EP_{p=2}) \geq 0.$$

Rearranging the terms, we find that

$$V_{p=1} - D \geq V_{p=2} \Leftrightarrow EP_{p=2} - E\Pi_{p=2} - E\Pi_{k=1} > EP_{p=1} - E\Pi_{p=1} - E\Pi_{k=2}.$$

Substituting for the expected prices from (17), we find that

$$V_{p=1} \geq V_{p=2} + D \geq 0 \Leftrightarrow EC_{p=2} \geq EC_{p=1}.$$

From (7), this inequality also implies that

$$V_{p=1} - D > V_{p=2} \Leftrightarrow IE_{p=2} > IE_{p=1}.$$

Thus, supplier 1 will become the PS if and only if the expected cost from (9) is lower when supplier 1 is the PS, rather than supplier 2. As a result, the inefficiency from (8) is also lower when supplier 1 is the PS.

Proposition 2:

Assume that $V_{p=1} \geq V_{p=2} + D$, so that supplier 1 is awarded preference for a price $V_{p=2} + D = E\Pi_{p=2} - E\Pi_{k=2} + D$. Taking note of the expression for the expected price $EP_{p=2} = EC_{p=2} + \Pi_{p=2} + \Pi_{k=1}$, we can express the net expected price as:

$$NEP_{p=1} = EP_{p=1} - (E\Pi_{p=2} - E\Pi_{k=2} + D) = EP_{p=2} - E\Pi_{p=2} + E\Pi_{k=2} = EC_{p=2} + E\Pi_{k=2} + E\Pi_{k=1},$$

where $EC_{p=2}$ denotes the expected cost for suppliers when supplier 2 has preference. Fix any value c_2 so that $c_2 \geq b_1(0)$, where $b_1(\cdot)$ represents the bidding function of the CS, supplier 1. Substituting for the expressions, the net expected price is

$$\begin{aligned} NEP_{p=1}(c_2) &= c_2(1 - G_1(b_1^{-1}(c_2))) + \int_0^{b_1^{-1}(c_2)} c_1 g_1(c_1) dc_1 + \int_0^{b_1^{-1}(c_2)} (b_1(c_1) - c_1) g_1(c_1) dc_1 \\ &+ (b_2(c_2) - c_2)(1 - G_1(b_2(c_2))). \end{aligned}$$

The first two terms correspond to $EC_{p=2}$ whereas the other two terms correspond to $E\Pi_{p=2}$ and $E\Pi_{k=1}$ respectively. We now compute the expected price in the efficient auction, $EP_{EA}(c_2)$ which equals the higher of the two costs:

$$EP_{EA}(c_2) = c_2 G_1(c_2) + \int_{c_2}^1 c_1 g_1(c_1) dc_1.$$

We can now compute the difference between these two expressions:

$$EP_{EA}(c_2) - NEP_{p=1}(c_2) = \int_0^{b_1^{-1}(c_2)} (c_2 - b_1(c_1))g_1(c_1)dc_1 + \int_{c_2}^{b_2(c_2)} (c_1 - c_2)g_1(c_1)dc_1 \\ + \int_{b_2(c_2)}^1 (c_1 - b_2(c_2))g_1(c_1)dc_1.$$

Since all the terms in the right-hand side are positive, we can conclude that indeed, $EP_{EA}(c_2) - NEP_{p=1}(c_2) > 0$ for all $c_2 \geq b_1(0)$. Now, assume that $c_2 < b_1(0)$. For a given c_2 , $EC_{p=2} + E\Pi_{p=2} = c_2$, so we have

$$NEP_{p=1}(c_2) = c_2 + (b_2(c_2) - c_2)(1 - G_1(b_2(c_2))).$$

Then, we can again compute the difference:

$$EP_{EA}(c_2) - NEP_{p=1}(c_2) = \int_{c_2}^{b_2(c_2)} (c_1 - c_2)g_1(c_1)dc_1 + \int_{b_2(c_2)}^1 (c_1 - b_2(c_2))g_1(c_1)dc_1,$$

As before, these two terms are positive. Thus, when supplier 1 wins preference we conclude that the $EP_{EA}(c_2) - NEP_{p=1}(c_2) > 0$ for all c_2 , and therefore $EP_{EA} - NEP_{p=1} > 0$.

Now assume that $V_{p=1} < V_{p=2} + D$, so that supplier 2 is awarded preference and the price of preference is $V_{p=1} - D$. Then, similarly as before, we can compute

$$NEP_{p=2} = EC_{p=1} + E\Pi_{k=2} + E\Pi_{k=1}.$$

Note that we have not used any particular property of supplier 1 or 2, in the discussion above. Thus, we can now reproduce the same derivations substituting c_1 for c_2 to obtain that $EP_{EA}(c_1) - NEP_{p=2}(c_1) > 0$ for every c_1 , and then again, $EP_{EA} - NEP_{p=2} > 0$. QED

Proposition 2:

The joint surplus of the buyer and the PS is $JS_{p=1} = v - EC_{p=1} - E\Pi_{k=2}$. Fix any value c_1 such that $c_1 \geq b_2(0)$, the joint surplus in the preference auction is

$$JS_{p=1}(c_1) = v - c_1(1 - G_2(b_2^{-1}(c_1))) - \int_0^{b_2^{-1}(c_1)} c_2 g_2(c_2) dc_2 - \int_0^{b_2^{-1}(c_1)} (b_2(c_2) - c_2) g_2(c_2) dc_2.$$

The second and third terms correspond to $EC_{p=1}(c_1)$, whereas the fourth term corresponds to $E\Pi_{k=2}(c_1)$. For the same cost realization c_1 , the joint surplus in the efficient auction is $JS_1(c_1) = v - c_1$. The resulting difference between the joint surplus in the preference auction and the efficient auction is positive:

$$JS_{p=1}(c_1) - JS_1(c_1) = \int_0^{b_2^{-1}(c_1)} (c_1 - b_2(c_2)) \cdot g_2(c_2) \cdot dc_2 > 0 \text{ since } c_2 < b_2^{-1}(c_1) \Leftrightarrow c_1 > b_2(c_2).$$

Now, for any value c_1 such that $c_1 < b_2(0)$, the joint surplus in the preference auction is $JS_{p=1}(c_1) = v - c_1$, the same as the joint surplus in an efficient auction. QED

Appendix 2: Results for the Pareto Family

Using equations (27) and (28), the difference in the willingness to pay of the stronger and weaker suppliers can be arranged as follows:

$$V_{p=1} - V_{p=2} = \frac{t_1 t_2}{(1+t_1)(1+t_2)} \cdot \left\{ \left(\frac{1}{t_2(1+t_2)} - \frac{(1+2t_2)}{t_2 \cdot (1+t_2)^2} \left(\frac{t_2}{1+t_2} \right)^{t_2} \right) - \left(\frac{1}{t_1(1+t_1)} - \frac{(1+2t_1)}{t_1 \cdot (1+t_1)^2} \left(\frac{t_1}{1+t_1} \right)^{t_1} \right) \right\}.$$

Since $V_{p=1} = V_{p=2}$ when $t_1 = t_2$, we examine whether $V_{p=1} > V_{p=2}$ (for $t_1 > t_2$). The term in braces is the difference between two expressions having the same general form:

$$B(t) = \frac{1}{t(1+t)} - \frac{(1+2t)}{t \cdot (1+t)^2} \cdot \left(\frac{t}{1+t} \right)^t.$$

Thus, the term in braces is positive if $B(t)$ is decreasing in t . The derivative of $B(t)$ is

$$\frac{dB(t)}{dt} = -\frac{(1+2t)}{t(1+t)^2} \cdot \left[\frac{1}{t} + \ln\left(\frac{t}{1+t}\right) \left(\frac{t}{1+t}\right)^t + \frac{(1+4t+6t^2)}{t(1+t)(1+2t)} \cdot \left(\frac{t}{1+t}\right)^t \right] < 0.$$

The first and third terms of this derivative are obviously positive, but the second term is negative. If $[1/t - \ln(t/(1+t))] > 0$, the positive first term would clearly dominate the negative second term. This follows from the fact that $[1/t + \ln(t/(1+t))]$ is decreasing for all t and approaches zero from above as $t \rightarrow \infty$. Thus, this derivative is negative and $V_{p=1} > V_{p=2}$ whenever $t_1 > t_2$.

After the stronger supplier wins the pre-auction for preference, her net expected profits are equal to $NE\Pi_{p=1} = E\Pi_{p=1} - [E\Pi_{p=2} - E\Pi_{k=2}]$. On the other hand, the expected profits of this stronger supplier in an efficient auction without preference would have been $E\Pi_1$. The difference in these expected profits is:

$$NE\Pi_{p=1} - E\Pi_1 = \frac{t_2}{(1+t_1)(1+t_1+t_2)} \cdot \left[-1 + \frac{(1+2 \cdot t_1)}{(1+t_1)} \cdot \left(\frac{t_1}{1+t_1} \right)^{t_1} - \frac{t_1(1+t_1)}{(1+t_2)^2} \cdot \left(\frac{t_2}{1+t_2} \right)^{t_2} \right]$$

The second term in braces is a decreasing function of t_1 . Moreover, the value of this term approaches 1 from below as $t_1 \rightarrow 0$, and approaches e^{-1} from above as $t_1 \rightarrow \infty$. Thus, this term is less than 1 for all t_1 , and the term in braces is therefore negative. Thus, the stronger supplier cannot increase her expected profits as a result of acquiring preference in the pre-auction.