Franchise bidding with differences in demand

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Abstract

Given a natural monopoly situation, Demsetz (1968) suggested that a monopoly franchise for the provision of a particular good could be awarded via competitive bidding as a substitute for traditional-style price regulation. This governance structure is referred to as franchise bidding. Despite the recent interest in franchise bidding, there have been no attempts in modelling a situation where there are differences in demand among potential suppliers due to reputational effects. We show that franchise bidding may, in this case, lead to inefficient results in the following sense. If the bidder with the lowest bid were barred from the auction, total surplus might increase, even under economies of scale. However, given the assumptions of economies of scale, non-crossing demand, and identical cost functions of the bidders, it is secured that total surplus would fall, if the bidder with the lowest bid were barred from the auction.

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I. Introduction

Given conditions of a natural monopoly, Demsetz (1968) suggested that the government could award a monopoly franchise for the provision of a particular good to a single firm as a substitute for regulation. The franchise is awarded via competitive bidding. The firms willing to provide the good submit bids that take the form of the proposed price which they would charge, in case they are awarded the franchise. The firm offering the lowest price wins the auction. This governance structure is referred to as *franchise bidding*.

Suppose the market demand function as well as the cost functions of all potential suppliers are static, and sufficient competition at the bidding stage is present. Assume that every bidder knows both the market demand function as well as his own cost function. Then, the cost functions of the most efficient bidders are very similar, which implies approximately zero profits for the winning bidder. Thus, franchise bidding leads to the selection of (one of) the supplier(s) generating the highest total surplus (the sum of profits and consumer surplus) among all bidders.[1] If this bidder, i.e. the bidder with (one of) the lowest bid(s), would have been barred from the auction, total surplus would not have risen.

Despite the recent interest in franchise bidding, there have been no attempts in modelling a situation where there are differences in demand among potential suppliers due to reputational effects. We show that franchise bidding may, in this case, lead to inefficient results. If the bidder with the lowest bid were barred from the auction, total surplus might increase, even under economies of scale. However, given the assumptions of economies of scale, non-crossing demand, and identical cost functions of the bidders, it is secured that total surplus would fall, if the bidder with the lowest bid were barred from the auction.

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1 For an overview of the efficiency properties of franchise bidding, see, e.g., Viscusi et al. (2000).

II. The Model

Auction design

An exactly defined monopoly franchise for the provision of a particular good is awarded via competitive bidding in a sealed-bid auction without a reserve price. The monopoly franchise is awarded to the firm bidding the lowest price. In the event of a tie, only one of the lowest bidders is chosen by a predetermined allocative mechanism, e.g. a lottery. The winning bidder has to supply the total quantity demanded of the good in the contractual period at the price offered by (one of) the bidder(s) with the second-lowest price(s).[2]

Bidders

There are $n \geq 3$ firms, $i = 1, \ldots, n$, bidding for the franchise for a certain contractual period. Denote the firm that offers the lowest price "1", the firm that offers the second-lowest price "2", etc. Their corresponding bid prices are $b_i = b_1, \ldots, b_n$; $b_i \in \Re_0^+$. The cost functions of the firms are labelled $C_1(\cdot), \ldots, C_n(\cdot)$. Each $C_i(\cdot)$ is a function of $q \in \Re^+$, which is the quantity demanded in the contractual period, is differentiable $\forall\, q \in \Re^+$, and exhibits economies of scale.[3] The inverse demand functions, $p_i(\cdot)$, of the firms, *i*, differ. Each $p_i(\cdot)$ is a function of q and is differentiable $\forall\, q \in \Re^+$ with $p_i(q) \geq 0$; $dp_i(q)/dq < 0$. For every $p_i(\cdot)$, there are exactly two $q \in \Re^+$ with $p_i(q) = C_i(q)/q$. All firms, *i*, are perfectly informed about their own cost functions, $C_i(\cdot)$, and their own inverse demand functions, $p_i(\cdot)$, in the relevant range of demand. They maximise profits when bidding and assume that they have at least one non-colluding competitor at the bidding stage. Production at the quantity $q_i(b_{i+1})$ always yields non-negative profits. None of the firms is financially constrained.

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2 We choose a second-price auction in order to exclude strategic behaviour.

3 The concept of (cost) economies of scale is described in Baumol et. al. (1988).

Proposition 1. *If the bidder with the lowest bid were barred from the auction, total surplus might rise.*

Proof. We give a numerical example which demonstrates that Proposition 1 holds. We assume that cost functions, $C_i(\cdot)$, are identical. Thus, they can be denoted $C(\cdot)$. They can be described as

$$C(q) = 100 + 4q\,. \tag{1}$$

The inverse demand functions of the bidder with the lowest bid, the bidder with the second-lowest bid, and the bidder with the third-lowest bid are given by $p_1(\cdot)$, $p_2(\cdot)$, and $p_3(\cdot)$:

$$p_1(q) = 54.5 - 0.25q\,,\; p_2(q) = 94.\bar{6} - 0.6q\,, \text{ and } p_3(q) = 105 - q\,. \tag{2}$$

The corresponding demand functions of the bidder with the lowest bid, the bidder with the second-lowest bid, and the bidder with the third-lowest bid, i.e. $q_1(\cdot)$, $q_2(\cdot)$, and $q_3(\cdot)$, can be described as:

$$q_1(p) = 218 - 4p\,,\; q_2(p) = 157.\bar{7} - 1.6p\,, \text{ and } q_3(p) = 105 - p\,. \tag{3}$$

It is a well-known standard result of auction theory that truth-telling is a dominant strategy for a bidder in a private values second-price auction (e.g., Wolfstetter, 1999).[4] Therefore, the bid prices of firm 1, firm 2, and firm 3 are their respective average cost prices:[5]

$$b_1 = 4.5\,,\; b_2 = 4.\bar{6}\,, \text{ and } b_3 = 5\,. \tag{4}$$

The firm with the lowest bid, i.e. firm 1, is awarded the franchise, and the price it must set is b_2. If firm 1 were barred from the auction, and firm 2 was awarded the franchise, firm 2 would have to set the price b_3.

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4 Even if the private values assumption is violated, auction models have shown in a variety of circumstances that a bidder's best response to rivals' strategies is to submit a bid at which she is indifferent between winning and losing (e.g., Milgrom, 1981; Levin and Harstad, 1986; Bikhchandani and Riley, 1991; Crew and Harstad, 1992).

5 Strictly speaking, there are two average cost prices for each of the inverse demand functions. Of course, only the lower one of these is relevant.

If all bidders may take part in the auction, the firm with the lowest bid, i.e. firm 1, is selected. It generates a total surplus, $TS_1(\cdot)$, in the market of:

$$TS_1(b_2) = \int_0^{q_1(b_2)} p_1(q)\, dq - C(q_1(b_2)) \approx 4999.61 \,. \tag{5}$$

If firm 1 were barred from the auction, and firm 2 was awarded the franchise, it would generate a total surplus, $TS_2(\cdot)$, in the market of:

$$TS_2(b_3) = \int_0^{q_2(b_3)} p_2(q)\, dq - C(q_2(b_3)) \approx 6749.54 \,. \tag{6}$$

Since $TS_1(b_2) < TS_2(b_3)$, it is obvious that total surplus would rise, if firm 1, i.e. the firm with the lowest bid, were barred from the auction, which concludes the proof. □

Sometimes the bidders' demand curves do not intersect in the relevant range of demand, i.e. demand is non-crossing. In general, this is quite unlikely to be the case. However, it may happen, if the number of bidders is small and the differences in demand between bidders are significant. Differences in demand between bidders may be significant, if there is a huge difference between bidders, as far as reputational effects are concerned.

Definition. Demand is called *non-crossing*, if $p_1(q) > p_2(q) > \ldots > p_n(q)\ \forall\ q \in \Re_0^+$ with $p_i(q) \geq 0$.

Proposition 2. *If cost functions are identical and demand is non-crossing, total surplus would fall, if the bidder with the lowest bid were barred from the auction.*

Proof. Because cost functions, $C_i(\cdot)$, are identical, they can be denoted $C(\cdot)$. Since all inverse demand functions, $p_i(\cdot)$, are differentiable $\forall\ q \in \Re^+$ with $p_i(q) \geq 0$, all $p_i(\cdot)$, $i \neq n$, are Riemann integrable on the interval $[0, q_i(b_{i+1})]$, and $\int_0^{q_i(b_{i+1})} p_i(q)\, dq$ always exists.

$$TS_i(b_{i+1}) = \int_0^{q_i(b_{i+1})} p_i(q)\,dq - C(q_i(b_{i+1})) = \int_0^{q_i(b_{i+1})} \left(p_i(q) - \frac{dC(q)}{dq} \right) dq - F \quad \forall\, i \neq n, \qquad (7)$$

where $F \geq 0$ are fixed costs.

Demand is non-crossing. Since the identical cost functions of the bidders exhibit economies of scale, marginal costs are always below average costs. Therefore, the following relationship holds:

$$\int_0^{q_1(b_2)} \left(p_1(q) - \frac{dC(q)}{dq} \right) dq > \int_0^{q_2(b_3)} \left(p_2(q) - \frac{dC(q)}{dq} \right) dq > \ldots > \int_0^{q_{n-1}(b_n)} \left(p_{n-1}(q) - \frac{dC(q)}{dq} \right) dq\,. \qquad (8)$$

As fixed costs, *F*, are identical for all bidders,

$$TS_1(b_2) > TS_2(b_3) > \ldots > TS_{n-1}(b_n)\,. \qquad (9)$$

By assumption, production at the quantity $q_i(b_{i+1})$ always yields non-negative profits. Thus, there is no involuntary production.

Firm *n* cannot be barred from the auction, since it is the bidder with the highest bid, which concludes the proof. □

III. Conclusions

In this paper, we showed that franchise bidding may lead to an inefficient choice of supplier in the following sense. If the bidder with the lowest bid were barred from the auction, total surplus might rise, in case there are differences in demand between bidders, even if the (identical) cost functions exhibit economies of scale.

Nevertheless, given the assumptions of economies of scale, non-crossing demand, and identical cost functions of the bidders, it is secured that total surplus would fall, if the bidder with the lowest bid were barred from the auction. In this situation, the adequate choice of supplier is secured despite of differences in demand.

At first sight, it seems adequate to change the selection criterion because of the potential inefficiency. Instead of choosing the firm with the lowest bid, one could generally select the firm generating the highest total surplus. However, an auctioneer usually does not know the (inverse) demand functions of the bidders. Thus, this selection criterion cannot be used in practice, and the inefficiency problem described in this paper remains unsolved.

What are the consequences for governments who increasingly contract out public services? As long as no significant differences in demand between bidders can be expected, the inefficiency problem cannot occur. However, if differences in demand can be expected, our results have implications for the application of franchise bidding. In this case, the government cannot be sure whether franchise bidding leads to the desired outcome or not. Thus, the case for franchise bidding is weakened, if differences in demand between bidders can be expected and the sufficient conditions of Proposition 2 (economies of scale, identical cost functions and non-crossing demand) cannot be expected to hold.

Thus, one might try to look for alternative ways of supplier choice. Unfortunately, it is unsure whether this search will be successful or not, since our results do not imply that there is some other practical method to select the welfare-maximising supplier, e.g. an administrative process, which is superior to franchise bidding.

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