E C O N O M I C S B U L L E T I N

Predatory Bidding in Sequential Auctions

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Abstract

The Turkish government wanted to sell two GSM (cell-phone) licenses in 2000 with sequential auctions. The winning bid in the first auction would be the reserve price for the second auction. This auction design gives incentives to ``predatory bidding." We show how a strategic firm will bid too high in the first auction; hence, no other firms can pay the reserve price in the second auction. The winning firm will make up for the high-bid in terms of more profit due to less competition in the market. We show that the government could have sold the two licenses and raised more revenue in a correctly designed sequential auction.

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1. Introduction

Auctions are increasingly used in allocating spectrum licenses since they provide efficient results. However, if the auctions are not designed carefully, seller might get unwanted results like less revenue. In this paper, we will study one such auction; the Turkish Global Mobile Telecommunications (GSM) auction held in 2000.

In this auction, the government wanted to sell two GSM licenses with a sequential auction.[1] The winning bid in the first auction would be the reserve price for the second auction. There were two incumbent firms in the market; hence, the government's objective was to increase competition in the cell-phone service market by having two more firms and to get as much revenue as possible. However, the government ended up selling only one license; no firm participated in the second auction.

Klemperer (2002) writes that Turkish GSM auction is biased towards creating monopoly. We model the auction formally and show that it will result in government selling only one license. We also compare this auction with a "no-reserve price" auction, and hence, show that the Turkish government's mistake was to set a reserve price in the second auction that can be manipulated by the firm that wins the first auction.

Ozcan (2004), in his working paper, also studies the same auction but compares it with a second-price auction. In his paper, firms' costs are private information and both licenses can be sold under some cases in the original auction. Our paper is different in a number of respects. First, we model the firms' costs as public information which gives a very simple and transparent model. Second, we show that only one license will be sold in all possible cases. Third, we compare the original auction with a no-reserve price auction and show that the government would be able to sell both licenses and get more revenue with the latter one. Therefore, we identify the reserve-price that can be manipulated by the firms as the auction design flaw.[2]

McMillan (1994) gives an overview of spectrum rights auctions and mentions the possibility of predatory bidding in sequential auctions. Pitchik and Schotter (1988), in an experimental study, shows that predatory bidding occurs in sequential auctions if bidders are budget constrained and bidders valuations are common knowledge. In our paper, bidders valuations are common knowledge but predatory bidding occurs due to the design of the auction.

2. The Model

The model mimics the real world case of the Turkish GSM auction as much as possible. We consider a cell-phone market with two incumbent firms. The government will sell (lease) two more cell-phone licenses in a sequential auction administered in the same period. Each auction format is a first-price sealed-bid auction. Firms can buy at most one license. The

[1] Ashenfelter (1989) and Jeitschko (1999) are a few examples that discuss sequential auctions.

[2] We became aware of this working paper well after starting our paper.

winning bid of the first auction will be the reserve price for the second auction; that is, the firm who wins the second auction will pay at least as much as the first auction winning bid.

We define the market inverse demand function as $p = A - bQ$, where p and Q stand for the market price and the market quantity demanded, respectively; A and b are positive numbers. Incumbent and entrant firms are identical. The firms have zero costs. There are at least 3 bidding (entrant) firms. We assume that firms in the cell-phone market will Cournot-compete at each period $t = 0, 1, ..$ once they get the licenses. Each firm's objective is to maximize its discounted profit (net of the bid they pay) with the discount factor $\delta \in (0, 1)$. All firms will decide how much to bid in the first and/or the second auction.

Assumption If there is a tie, the government will award the license with a lottery that only the highest bidders participate.

In the proposition below, we characterize how the firms will bid in the first auction and prove that no firm will win in the second auction.

Proposition 1 *In the first auction, all firms will bid* $\frac{A^2}{16b(1-\delta)}$. *No firm can win the second auction.*

Proof We denote the discounted profit of a firm with π_j and per period quantity by q_j where the subscript $j = 3, 4$ denotes how many firms are competing in the market. After straightforward "Cournot-oligopoly profit maximization" calculations, equation 1 show q_j and π_j, respectively.

$$q_j = \frac{A}{(j+1)b} \qquad \pi_j = \frac{A^2}{(j+1)^2 b(1-\delta)} \tag{1}$$

If the firms bid high enough in the first auction, then no firm will enter to the second auction. Therefore, each firm will bid in order to prevent the fourth firm to enter to the market until their profits are zero. That is, they will bid $\pi_3 = \frac{A^2}{16b(1-\delta)}$ in the first auction. One firm will be awarded the license via lottery according to our assumption. Then, in the second auction, the remaining firms can bid at most $\pi_4 = \frac{A^2}{25b(1-\delta)}$ but this is less than the reserve price, and no firm will win the second auction. ■

The firms take advantage of the auction design flaw and only one license is sold. Firms are willing to give up immediate money by bidding high since they know that they will make up this in the form of higher profits due to the less competition in the market. Hence, government's increased competition objective is not achieved.

Now, we assume that the government designs a sequential auction but does not specify a reserve price for the second auction.[3] We will call this auction a "no reserve price auction."

Proposition 2 *In a no reserve price auction, firms will bid* $\frac{A^2}{25b(1-\delta)}$ *in both auctions. Both licenses will be sold.*

If a firm bids π_3 in the first auction, then it will make a loss since it can only make a (gross) profit of π_4 in the market which is less than its bid. Once the reserve price condition is

[3]This is actually same as a simultaneous auction in which two licenses are sold.

removed from the auction design, firms can bid at most π_4 since there is no way of preventing entry of the fourth firm; hence, both licenses are sold. Not only that the government can sell two licenses, but it will also increase its revenue according to corollary 3 below. This shows that setting the reserve price that can be manipulated with a bid in the first auction is the flaw in the auction design.

Corollary 3 *The government will have more revenue with a no reserve price auction compared to the original auction.*

Proof In the no reserve price auction, two licenses will be sold at a lower price compared to the original auction. In the original auction, however, only one license will be sold. The following calculation shows that revenue is higher in the no reserve price auction.

$$\frac{A^2}{16b(1-\delta)} < 2\frac{A^2}{25b(1-\delta)} \Longleftrightarrow 12.5 < 16 \tag{2}$$

Hence, revenues are always greater with the no reserve price auction.

■

If the government had not specified a reserve price, it would have been able to sell two licenses (which means more competition and more social welfare) and would have raised more revenue.

3. Conclusion and Discussion

We would like to discuss the possibility of one firm being strategic and the others being not strategic. Not strategic in the sense that they will bid π_4 in the first auction. If the strategic firm believes that the other firms are strategic, then only one license will be sold and the results will be the same as the original auction! If the strategic firm knows that the other firms are not strategic, then we will get the results of "no reserve price" auction.[4]

We show how and why a sequential auction results in predatory bidding, and hence, less competition in the market. Turkish government sets a reserve price in the second auction that depends on the first auction's winning bid. This gives the firms the incentive of predatory bidding. We show that in a sequential auction without a reservation price, two licenses would be sold and more revenue would be raised.

References

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[4]The only change will be that the strategic firm will bid slightly higher (we can say 1 cent more, if we change our continuous bid assumption to discrete bids of multiples of 1 cents) than π_4 in the first auction.

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