Secondary Markets in Auctions With Endogenous Valuations

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September 1994

Abstract

Introducing secondary markets in endogenous-valuations auctions can increase or decrease the seller's revenue and affects the final allocation. Particularly, it restores Gilbert-Newbery's persistency result. Lastly, when auctioning licenses, the commodity's nature is also crucial for the auction's outcome.

JEL classification: D44

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1 Introduction

The sequential auction of government-created assets is becoming widespread, with the purported aim of promoting allocative efficiency and raising revenue.¹

A main feature of these auctions is that players' valuations of the auctioned objects are dependent on their final allocation: these are termed auctions with endogenous valuations.² Some recent theoretical papers address them

*Thanks are due to Pedro P. Barros, Fernando Branco, Luís Cabral, António Leite and Diogo de Lucena for helpful comments and suggestions.

¹A recent example involves radio-spectrum bands auctioned by the Federal Communications Commission. See *The Economist*, July 23, 1994, p. 64, and McMillan (forthcoming) cited therein.

²For an analysis of multiple-unit auctions with independent private valuations see Maskin and Riley (1989).

[e.g., Gale and Stegeman (1993), Krishna (1993)], and implicitly assume the absence of a post-auction secondary market. We show, by extending an example borrowed from Krishna (1993), that the existence of a secondary market does have important consequences concerning: (i) the seller's revenue, which can either decrease or increase; (ii) the final allocation of the auctioned commodity. In particular, we show that the secondary market restores Gilbert and Newbery's persistence of monopoly result, in stark contrast to Krishna's (1993) conclusion. Hence, the existence of a secondary market can affect both allocative efficiency and the revenue raised.

Furthermore, when considering a secondary market, besides the relative bargaining power of the bidders, another parameter emerges which affects the auction revenue and the final allocation: the nature of the commodity (good vs. service) is crucial when licenses to produce or import are being auctioned.

2 The Model

There are two bidders, I and J . Two equal units of the commodity are sequentially auctioned in the first two stages of the game, followed by the final stage where players obtain a monetary reward from using the commodity. Let $(\pi_I(k), \pi_J(2 - k))$, $k = 0, 1, 2$ be the ordered pair of the players' monetary reward gross of the bidding costs incurred during the auction, when player I has successfully bid for k units.

Borrowing from Krishna's (1993) example, the three possible allocations are assumed to result in the following final-stage rewards: (i) $(\pi_I(2), \pi_J(0)) = (20, 0)$; (ii) $(\pi_I(1), \pi_J(1)) = (10, 9)$; and (iii) $(\pi_I(0), \pi_J(2)) = (0, 10)$.³ The outcome tree in Figure 1 helps in solving the game. Suppose player I has obtained the first unit. It is willing to bid at most $\pi_I(2) - \pi_I(1) = 10$ for the second, whereas his opponent is willing to bid at most $\pi_J(1) - \pi_J(0) = 9$ for that same unit. Hence, player I outbids J with a bid of 9, in square brackets next to the respective tree branch. Hence, the payoff to reaching this sub-game is (11,0). Recursive application of this reasoning yields the sub-game perfect solution of the game: players I and J successfully bid for one unit each, with bids equal to 1 and 2, respectively. They get final rewards net of bidding costs of 9 and 7, respectively, whereas the seller's revenue equals 3, for a total surplus of 19. If one thinks of player I as an incumbent monopolist and J as an entrant, one concludes, in stark contrast to Gilbert and Newbery (1982), that monopoly is eroded.

Consider now the existence of a post-auction secondary market. Then, the allocation described above is not an equilibrium: Player I is willing to offer up to $\pi_I(2) - \pi_I(1) = 10$ for player J 's unit, and J is willing to sell it, since by using it itself it can earn only 9.⁴ We are facing here a bilateral monopoly (in the post-auction market) where the seller and buyer reservation

³See Krishna (1993), pp. 149–51.

⁴The bid cost of 2 being sunk, it is clearly irrelevant to the decision regarding how much to sell the unit for.

FIGURE 1. *Game without secondary market.*

prices ensure that a transaction will occur.

This deviation raises several questions. First, does a secondary market ensure that monopoly persists? It is easy to see that with a secondary market, the final allocation is such that it maximizes the sum of the players' rewards, $\pi_I(k) + \pi_J(N - k)$, where N denotes the number of auctioned units. All other allocations are liable to the type of deviation outlined above. In games where $\pi_I(k) + \pi_J(N - k)$ is maximized for $k = N$ —the very class of games associated with Gilbert and Newbery (1982)—monopoly will persist, in stark contrast to Krishna's (1993) conclusion.

Second, is the secondary market active in equilibrium? Third, how does the bargaining power of the players in the secondary market affect the solution of the game? Fourth, is the seller's revenue affected by the existence of the secondary market? Is it always increased? How does that revenue vary with the bargaining power of the players?⁵ Allowing explicitly for a

⁵Note that, in the absence of a secondary market, the seller's revenue amounts to 3, a mere 15% of the value of the two units to the highest-valuation buyer, namely player I .

FIGURE 2. *Game with secondary market.*

secondary market will enable us to address all these questions.

Let $\alpha \in [0, 1]$ measure player I 's bargaining power by having it represent the percentage of the gains from exchange it obtains in the secondary market. Then, player I will pay player J $\alpha 9 + (1 - \alpha)10$ for one unit, and $\alpha 10 + (1 - \alpha)20$ for two.⁶

The solution of the generalized auction can be obtained with the help of Figure 2, similar to Figure 1.⁷

Several conclusions are in order. First, the secondary market is active in equilibrium, since the first unit to be auctioned is bought by player J .

Second, the seller's revenue increases monotonically with player J 's bargaining power, and can be as high as the highest-valuation allocation, i.e.,

⁶Notice that the payment for two units equals $\alpha 10 + (1 - \alpha)20$ irrespective of whether bargaining is simultaneous or sequential. In the latter case it amounts to $\alpha 1 + (1 - \alpha)10$ for the "first" unit, and $\alpha 9 + (1 - \alpha)10$ for the "second."

⁷Note that both players have equal valuations in both second-stage sub-games. Hence, the winning bid in square brackets can be found next to both branches of each sub-game. However, whatever tie-breaking rule is adopted, it does not affect the valuations associated with each tree node.

20 for player I . In fact, with a secondary market, it equals $20 - 18\alpha$, varying between 2 and 20. Thus, it can either exceed or fall short of the revenue without the secondary market (which was 3).

The monotonicity result relating α to the seller's revenue is intuitive: the larger the post-auction market power of the player with a lower valuation for both units, the more aggressive its bidding will be. This, in turn, increases the seller's revenue, and correspondingly decreases both players overall payoffs (which equal 10α and 8α , respectively).

It is also intuitive why the introduction of the secondary market reduces the seller's revenue when $\alpha \rightarrow 1$. When the highest-valuation bidder (I in our case) has significant bargaining power it can bid less aggressively. This, in turn, allows the other bidder to reduce its offer, thus decreasing the seller's revenue.

3 Applications

In cases where the auction is for licenses to produce or import, one may be tempted to ignore the possibility of a secondary market by arguing that the seller can prevent successful bidders from trading licenses by imposing a "use-it-or-lose-it" clause. This restriction can be circumvented, if the secondary market is established for the commodity itself, rather than for the licenses. The successful bidder can simply produce or import the quantity which the highest-valuation bidder would have produced or imported had

it obtained that unit, and offer to sell it that quantity. The analysis above would still apply, and the end result, as far as monopoly persistence is concerned, would remain. In cases where the commodity associated with capacity is a *service*, it is easier for the seller to prevent the emergence of a secondary market by explicit prohibition, since it is impossible to produce or import the service associated with the auctioned licenses and then sell it to other bidders, whereas such a procedure is feasible for a *good*.

This issue is empirically relevant. Auctions exist or have been proposed for import quota licenses [Bergsten *et al.* (1987)], takeoff and landing rights, for which a secondary market is being proposed [Gale and Stegeman (1993)], taxi medallions in New York, where a secondary market also exists, as well as to art and wine [Ashenfelter (1989)], government procurement contracts, timber and other agricultural products, mineral rights, government debt, pollution rights, broadcast licenses, and other government-created assets [Gale and Stegeman (1993)].⁸

Our sequential auction with secondary market when player J has all the bargaining power in the secondary market ($\alpha = 0$), can generate the same revenue as a simultaneous auction where all units are bundled together. This contrasts with Gale's (1990) opposite conclusion and raises the issue of the extent to which the secondary market is a substitute for bundling of the

⁸These references should be taken simply as examples of markets in which the existence of a secondary market should be considered and its effects analyzed. This enumeration should not be taken to imply that monopolization of all such markets is to be expected.

auctioned commodity, as far as the seller's revenue is concerned.

From a policy perspective, it is interesting to note that a conflict of objectives may emerge in cases where the seller is a government which can prevent the emergence of a secondary market. On the one hand, and from a welfare perspective, the government prefers the erosion of monopoly, in which case the secondary market should not be allowed to function. On the other hand, allowing the secondary market to operate may increase the government's auction revenue.⁹

⁹Recent discussions of quota auctions as a source of revenue were held in the US: see Bergsten *et al.* (1987, pp. 7-9). Morrison and Winston (1989) report that airport authorities are pressured to maximize revenues.

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