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Multi-object auctions with resale: Theory and experiment ☆

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ABSTRACT

We study multi-object auctions in the presence of post-auction trade opportunities among bidders who have either single- or multi-object demand. We focus on two formats: Vickrey auctions where package bidding is possible and simultaneous second-price auctions. We show that, under complementarities, the Vickrey format has an equilibrium where the objects are allocated efficiently at the auction stage whether resale markets are present or not. The simultaneous second-price, on the other hand, leads to inefficiency with or without resale possibility. Our experimental findings show that the possibility of resale in second-price auctions decreases the efficiency rate at the auction stage compared to the no resale case. However, after resale, the efficiency rate in second-price is as high as that of Vickrey auction without resale outcomes in the experiment. Preventing resale neither benefits nor hurts auction revenues in a second-price format.

1. Introduction

The large scale of privatization of assets, such as spectrum licenses, and gas and electricity supply, attracts attention to multi-object auctions (see e.g. Krishna and Perry, 2000; Ausubel, 2004). Unlike the auctioning of non-government owned assets, the efficiency of the allocation, rather than revenue maximization, is the main objective of these auctions (see McMillan, 1994; Ausubel and Cramton, 1999; Cramton, 2002). This objective may be achieved at the auction stage or by allowing post-auction trade among bidders.

As a means of allocating objects efficiently, Vickrey auctions are often considered. The attractiveness of a Vickrey auction is that it extracts the true value of the bidders via simple strategies that are independent of the underlying distribution of values (see Ausubel and Milgrom, 2006). On the other hand, conducting a Vickrey auction, explaining its pricing rule and its transparency to the bidders, can be quite complex, especially when there are large packages of objects and many bidders. Due to these complexities, most spectrum auctions in the US do not allow for package bidding and, in rare cases, such as a 700 MHz auction, allow bids on only a limited number of packages (Cramton, 2002). Running simultaneous second-price auctions may be more practical but may lead to inefficient allocations when complementarities exist (see de Vries and Vohra, 2003; Cramton et al., 2006). In that case, bidders are naturally interested in resale at the conclusion of the auction.

Post-auction trades among bidders are observed in various settings, such as auctions of antiques, real estate, art, emission allowances, or spectrum licenses. In government auctions, where one would expect the government to be able to

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forbid resale, it is hard to prevent companies from merging (as was the case after the UK spectrum auctions in 2000 and 2003).[1] Therefore, it is important to understand both theoretically and empirically how auction outcomes are affected by the existence of resale markets. Various studies have shown that, typically, auction behavior is affected by the possibility of resale and therefore the efficiency and revenue of the auction may change depending on the existence of resale markets (see e.g. Haile, 1999, 2000, 2001, 2003; Gupta and Lebrun, 1999; Hafalir and Krishna, 2008; Zheng, 2002; Garratt and Tröger, 2006).

When multi-objects are auctioned, bidders' demands may differ depending on how large or small they are. For example, in FCC auctions, some bidders are smaller than others because of geographical restrictions or financial constraints, or because they have different uses for the objects. Therefore, they prefer to bid on only a small number of licenses. Moreover, in spectrum auctions (as well as in many other settings), large companies might value multiple licenses to serve large geographical locations more than the sum of the values of each license because the marginal cost of serving a larger area can be lower. In our model, we consider one large bidder (the global bidder) and N small bidders (the local bidders). There are N units to be sold. The global bidder is interested in all units, and each local bidder is interested in a single unit (see Krishna and Rosenthal, 1996, and Chernomaz and Levin, 2012 for similar settings[2]). The valuations of the bidders are independent and private. This setup resembles the situation of telecommunications firms interested in radio-frequencies in different areas, which might have independent valuations due to the varying demands in different geographical regions.

We study both Vickrey auctions where package bidding is allowed and simultaneous second-price auctions where an auction is conducted for each unit. We consider the case where resale among bidders is allowed and the case where it is not. The resale markets, when they are allowed, are designed so that the winners of the auction can make a take-it-or-leave-it offer to the unsuccessful bidders as in Hafalir and Krishna (2008).

We show that the Vickrey auction with package bidding has an equilibrium that allocates objects efficiently at the auction stage with or without resale possibility. Particularly, truthful value bidding is equilibrium when resale is allowed. Hence, resale trade will not occur after a Vickrey auction in that equilibrium. On the other hand, simultaneous second-price auctions do not allocate the objects efficiently at the auction stage when resale is possible or prohibited in any equilibrium. Moreover, in any equilibrium of these auctions, full efficiency cannot be achieved by resale.

Based on these theoretical findings, it is important to investigate experimentally the tradeoff between running a complex but efficient Vickrey auction, and a simple but inefficient simultaneous second-price auction. First, our Vickrey auction experiments with or without resale do not achieve efficiency. The complexity of this pricing rule makes it hard for the subjects to discover that simple efficient equilibrium. Additionally, our experiments compare simultaneous second-price auctions when resale is allowed and not allowed in terms of efficiency. We show that the presence of resale markets diminishes the efficiency rates at the auction stage of the second-price format compared to the no-resale case. However, in this format, after resale, efficiency rates improve to the level of the outcome of our Vickrey auctions without resale experiments.

Although revenue may not be the main concern of government auctions, resale activity is typically considered a loss of the seller from the gains of trade. Contrary to this intuition, our experiments show that the resale possibility does not affect seller's revenue significantly in second-price auctions.

The existing models of auctions with resale in the literature mainly consider single object problems. The literature on auctions with resale provides six main reasons for resale: (i) new information regarding the values of objects arrives after the auctions (see Haile, 1999, 2000, 2001, 2003 and Gupta and Lebrun, 1999), (ii) new buyers arrive after the auction is over (Haile, 1999), (iii) asymmetry in the auction may lead to inefficient allocation (Zheng, 2002; Hafalir and Krishna, 2008), (iv) presence of speculators in the auction (Garratt and Tröger, 2006; Pagnozzi, 2007, 2009, 2010), (v) coordination on collusive outcome (Garratt et al., 2009), and (vi) misperception of resale markets (Georganas, 2011). Our setup is closest to the third type because a multi-object auction setting with complementarities provides a natural asymmetry in terms of demand of bidders and therefore may lead to inefficient allocation under different formats.

The experimental literature on auctions with resale is limited, probably because the theoretical developments on this topic are relatively recent. Lange et al. (2011) experimentally study symmetric first-price auctions where bidders' valuations are initially noisy and there is room for resale. Georganas and Kagel (2011) test Hafalir and Krishna (2008). Georganas (2011) experimentally studies symmetric English auctions with resale and shows deviations from equilibrium that he interprets as misperception of resale. The only other paper, to the best of our knowledge, studying a multi-object setting with resale possibility is Pagnozzi and Saral (2013). Their paper complements ours as they analyze different bargaining mechanisms at resale stage following a uniform price auction without complementarities.

The rest of the paper is organized as follows. Section 2 presents our theoretical model and states the theoretical results that motivate the experiments. Section 3 summarizes the experimental design and findings. Section 4 concludes. The proofs of the statements presented in the theoretical section and the instructions used in the experiments can be found in online Appendices A1 Proofs and A2 Experimental instructions.

[1] Hutchison, a telecommunications company, bought TIW, a Canadian firm which won the most valuable license, just after the spectrum auctions in 2000. Pacific Century Cyberworks, a large Hong Kong company, took over Red Spectrum and Public Hub, two small firms, less than a year after the UK spectrum auctions in 2003.

[2] Krishna and Rosenthal (1996) develop this model in order to study the FCC auctions of licenses for the radio-frequency spectrum. Chernomaz and Levin (2012) study theoretically and experimentally first-price auctions in this setting. Neither of these models allows for post-auction resale.