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Comment on "Thirteen Reasons Why the Vickrey-Clarke-Groves Process is Not Practical" by Michael Rothkopf

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The use of auctions to trade goods and services is pervasive and growing. With the need to handle the complex problem of selling or buying multiple items simultaneously, the study of combinatorial auction designs has became a thriving research area for experimental economists, optimizers, game theorists, psychologists, and sociologists. The mathematically elegant Vickrey-Clark-Groves design has been at the heart of this research. However, as Rothkopf states, the VCG design has rarely been used. Rothkopf describes why the design is impractical and argues that "research that aims to maintain the dominant truth-telling strategies while compromising on the other practical issues is of limited practical value". I agree with Rothkopf that participants in auctions have conflicting goals, and it is sometimes impossible to develop an auction design that can achieve all of these goals simultaneously. Tradeoffs must therefore be made in the choice of a design based on the characteristics that are best for the given situation. Auction design choices are likely to be application-specific, based on market competition, the type of bidders who will be participating[1], the likelihood that the auction will repeat periodically, the value of the goods being offered, and many other factors.

In this short comment I would like to expand on Rothkopf's discussion by listing a collection of goals that we seek to achieve with combinatorial auctions and then list some of the auction design choices that can impact the auction's performance. I encourage others to add to these lists, as I am certain that I have overlooked important issues.

Let me begin this discussion by asking the simple question: Why do people sell or buy goods and services via an auction mechanism[2]? There are a number of answers to this question. Often the price of the good or goods has not been determined and the bidders wish to determine the minimum price that they must pay given that they must compete with others for the ownership of this good. From the seller's perspective, submitting goods to an auction may increase the number of buyers, thereby increasing the potential for competitive bidding and higher selling prices. Thus, an auction is a relatively simple mechanism to determine market-clearing prices. The determination of the selling price by auctions is therefore perceived as both less haphazard and fairer than if the price were set by bilateral negotiations since all auction participants must play by the same set of rules. An auction mechanism that repeats is dynamic and reacts to changes in market conditions and provides the market with feedback on prices and availability of products and services. One of the most often cited goals of auction design is that the auction ends with the goods in the hands of the entity that values them the most (usually labeled an "efficient" result).

As Ostrovsky [2006] says: "Designing a good combinatorial auction is hard; sometimes, it is not even exactly clear what makes such an auction 'good', since the seller may care about several objectives: expected revenue; allocative efficiency; simplicity, transparency, and robustness of the rules; the speed of execution; an so on.” We begin our discussion by listing some of the goals often stated as necessary for a good auction result:

1. The auction results in an efficient outcome, i.e., all items are collectively allocated to the bidders that value these items the most.
2. The auction is fair to all bidders.
3. The auction cannot be gamed, i.e., truthful bidding is an optimal strategy for all bidders, and the auctioneer has no reason to supply “shills” or misrepresent the bids provided.
4. Bidders can create and place bids on any and all collections of the objects being auctioned. Thus, bidders can express precisely what they want to win and the price that they are willing to pay for the purchase.
5. The auction results in maximum revenue to the seller.
6. The auction ends in a reasonable amount of time.
7. The auction has limited transaction costs, i.e., the rules are not so difficult or the bidding so complicated that a straightforward bidder finds it difficult to participate.
8. The auction allows price discovery.
9. Collusion and communication among bidders is discouraged.
10. The auction is simple enough for the auctioneer to provide fair and correct responses back to bidders (i.e. the auction is computationally feasible and scalable for the auctioneer in terms of determining the winners and the prices) and for the bidders (i.e. bidders are capable of determining the appropriate response to the prices or quantities provided by the auctioneer).

So, what are auction design decisions that might impact these goals? I list a collection of such decisions below. Here too, this list is far from complete and I hope others will add to this discussion by providing other critical features:

1. What are the items being auctioned? Often the answer to this question is straightforward: It is a physical object whose ownership will be transferred to the winner. However, in other auctions, (e.g. rights to use the airwaves (spectrum auctions), rights to takeoffs and landings at airports, supply-chain transactions where the seller is guaranteeing services on an as needed basis), the question is much more complex and the success of the auction may rest on how well the rights and obligations that go along with the purchase are specified.
2. Are items offered sequentially or simultaneously?
3. Will the auction impose reserve prices? Is so, will the reserve prices be disclosed before the auction begins, after the close of the auction, or never?
4. Is the auction a sealed-bid auction or an ascending auction?
5. Are there restrictions on what the bidder can submit as bids? (Is the bidder restricted in the number or type of bids that can be submitted?)
6. Does the bidder need to supply any credentials to be able to participate?
7. Is this auction likely to be repeated regularly and/or is the auction for a unique set of goods or services?
8. How does one determine the winners and what prices do the winners pay for the goods that they have won?
9. What bid and bidder information will be provided to others during and after the auction?
10. If the auction is ascending:
    a. How are prices set?
    b. Are there any rules that force participation throughout the auction or can a bidder “snipe” by providing a bid only at the very end of the auction?
    c. What is the stopping rule?
    d. How long do proposals remain viable?

e. How does the auction end, i.e. what is the stopping rule?

Although this list is not complete, it highlights the fact that a complete auction design is a complex entity. The design needs to take into consideration who is running the auction and who is participating. For example, government auctions often require that all information collected during the auction be available to the public. Alternatively, many private auctions work to maintain the confidentiality of the information provided. Some auctions restrict severely the complexity of the auction by restricting the bidding language or the number and types of bids submitted, while other auctions (such as supply-chain auctions) allow significant flexibility through the inclusion of side-constraints. Ascending auctions have proven to be the most successful way of auctioning high-valued items such as art objects or antiques, but many private auctions such as supply-chain auctions are sealed-bid auctions.

Similarly, much has been written about the use of alternative bidding languages. The bidding language and other bid restrictions can have significant impact on both the auctioneer's computations (winner determination and pricing) and the bidder's ability to respond to new price announcements. With a restrictive bidding language, one may lose efficiency. Conversely, with a more flexible bidding language, one may not be able to auction a large number of goods simultaneously. Similarly, one can consider the trade-off between speed and computational correctness, i.e. Is it necessary to prove optimality of the winner-determination problem, or is it better to keep the auction moving along with new prices obtained from approximate solutions? Is it better to keep the auction simple by limiting the number of items auctioned simultaneously or auction more items acknowledging the associated increase in complexity? Each of the rules has implications for other rules. A complete auction design must consider the overall effect of all interactions.

Single-object auctions such as Ebay have been widely studied and we have learned much about bidder behavior from such auctions. But, even in these simpler designs, the behavior of bidders is anything but straight-forward and rational (see Steiglitz, 2007 and the references therein for more on this topic).

Although the task of designing successful auctions may seem daunting, we can use the results of theory to provide us with benchmarks to measure how "close" we come to the ideals and what the tradeoffs are when we move away from one goal in order to move closer to another. The Vickrey-Clarke-Groves (VCG) mechanism offers such a theoretical benchmark due to its incentive properties. Some recent research has focused on auction designs based on allocation schemes that seek to minimize the deviation from VCG allocations while at the same time satisfying other pragmatic considerations (Parkes et al.). Thus, although the VCG auction might not be a "usable" auction design, it has provided us with an important goal to strive toward. It has also inspired the creation of alternative designs that are far more usable and work toward the same goals. Recent research also suggests that hybrid designs may move us closer to obtaining the overall goals stated above. Clock-proxy [Ausubel, Cramton, and Milgrom], multi-clock phases [Porter, et al] and even a 3-stage auction [Day and Raghavan] suggest it may be possible to reduce the communicational and computational complexities by first using simpler auction mechanisms to determine valuation information and then using a more complex auction design to determine the final packaging, assignment, and pricing of the items.

Clearly, there is a vibrant, interdisciplinary research area that requires the talents of economists, computer scientists, operations researchers, psychologists and sociologists. Ebay has provided us with an enormous amount of data that confirms that bidders do not always act rationally. Thus, we must better understand the motivations and emotions that impact this behavior. Complex laboratory experiments and analysis of real-world auction will provide us with answers to the more-complicated behaviors. When and why do bidders violate economic rationality? What happens when a bidder's goal is not to acquire items in the auction but rather to assure that a competitor does not acquire the items? I would love to see analysis that answers such questions as: How do bidders respond (a) when the number of items expands from a few items to hundreds of items, (b) when the bidders are severely budget constrained or (c) when the transaction costs are extremely high (i.e. when they must use complex decision tools to determine their bids)? Intelligent agents (bots) can process massive bits of information. Such bots coupled with human intelligence can create auction environments that will allow us to model and test much more complex auction designs and strategies. The field of operations research can help by providing the tools to determine the tradeoffs between conflicting goals, by building the decision-support tools needed to make rational complex responses to price or quantity information, by improving the algorithms used to determine the winners and the associated prices, and by developing the game-theoretic underpinnings that will help us determine the quality of the auction design. There is something for everyone in this research area: theoretical development, algorithmic development, application-based decision-support tools, data analysis, probabilistic inference, and, of course, the study of human behavior. For those interested in learning more about both the theory, implementation and applications of combinatorial auctions, see Cramton, Shoham and Steinberg [2005].

Endnotes

[1]One might consider an auction design with high transaction costs when the participants are major companies who are bidding on very valuable commodities (such as telecommunications spectrum or airline slots) and can afford to invest in valuation studies and sophisticated software tools. On the other hand, one might want a much simpler design when buying relatively low-cost commodities.

[2]In this note, I will always describe the case of a single seller having a number of items for sale and multiple agents who are interested in buying the items. Since the multiple seller/single buyer and the multiple buyer/single seller are symmetric, results for one case follow for the other.

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