Comparing Open Outcry and Online Auctions: Evidence from North Dakota Mineral Auctions

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1 Research Question

The North Dakota state government made the choice to move their mineral (oil and gas) lease auctions online in a way that alternated between in person and online auctions for a period of 5 years. This provides a natural experiment for me to study the effects of a switch from open outcry ascending English auctions to online ascending auctions. My goal is twofold. First, I would like to measure the revenue difference between the online and open outcry auctions. Second, I would like to calibrate a structural model which recovers the distribution of bidder values and allows me to perform counterfactual policy experiments which help explain the revenue difference.

2 Literature Review

I draw my model of bidder behavior in auctions from the existing literature on auction theory. For my purposes, Krishna (2009) is a textbook which provides the relevant results on optimal bidding strategies in different auction formats conditional on value.

For identification of my structural model, I draw heavily on the work of Hernández, Quint, and Turansick (2019). Their paper proves conditions under which second price auctions with private values and unobserved heterogeneity can be identified from data on the number of participants in the auction and the transaction price. Their paper is novel in that it is the only one which is able to identify auctions with unobserved heterogeneity without assuming that some non-winning bidders bid up to their value or that the seller observes the unobserved quality of the object being sold and sets reserve price accordingly. They use semi-parametric identification methods developed in Gallant and Nychka (1987). These methods are very useful to me because I intend to use a private values assumption in my modelling. There is good reason also to assume that with oil and gas leases there is some heterogeneity that is observed by all the bidders, but unobservable to me, the econometrician. Therefore, the Hernández, Quint, and Turansick 2019 model is particularly well-suited to my setting. While

it has not been applied to oil and gas auctions before, in their paper, they try out their novel econometric technique on some data from eBay auctions. The online auctions that I study are actually quite similar to eBay auctions, so this paper acts as a useful guide.

I will also rely on some of some of the partial identification ideas presented in Haile and Tamer (2003). In particular, I rely on the assumption that in an English auction all bidders may not necessarily bid up to their valuation, but the bidder with the second highest valuation will. The broader purpose of this paper is that most real-world auctions don't fully satisfy the theoretical assumptions of the ideal second-price button auction. There are frictions such as bidding increments and the fact that bidders won't necessarily bid at every increment. The novel contribution of this paper is its ability to identify bounds on the distributions of bidder values from a much slimmer set of assumptions on bidder behavior. Given the non-idealized format of my auctions, I benefit tremendously from identification results that don't require as many assumptions.

I contribute to an extensive existing literature that makes comparisons between first price and second price auctions using models with unobserved heterogeneity and endogenous entry. The seminal revenue equivalence result, first proved in Vickrey (1961), shows that, under certain conditions, first and second price auctions should bring in equivalent revenues. There has however been an extensive empirical literature which has shown this result not to be the case in many real-world auctions which diverge from Vickrey's model of bidder valuation and behavior. Athey, Levin, and Seira (2011) estimate a structural model with unobserved heterogeneity, private values, and endogenous entry of first price sealed bid timber auctions and use it to make comparisons with ascending English auctions. They find that the sealed bid first price auctions can give higher revenues than their open outcry counterparts in settings with even a small amount of collusion. Unfortunately, I am unable to apply their structural model to my setting because it can only be identified from the set of bids in a first price auction. That said, the paper does extensive work simulating counterfactual policy experiments, and I intend to use similar techniques in my paper to discuss the possibility of collusion in the open outcry auctions as a driver of the revenue difference. Kong (2020) explores a mineral auction setting where first price auctions give higher revenues than their

open outcry counterparts. She shows that uncertainty about number of entrants combined with bidder risk aversion explains this difference. While in my setting there is not uncertainty about number of entrants, the techniques used in this paper to compare the auction formats will prove quite useful for my work. Additionally, there are useful discussions in this paper of how to perform structural inference on bid data from mineral auctions which is quite relevant to my work.

My contribution lies at the intersection of the prior literature comparing first and second price auctions and a literature empirically examining eBay-style online auctions. Hasker and Sickles (2010) summarize the state of the eBay literature. They highlight the fundamental challenge that it is hard to reconcile the bidding strategies observed on the platform with a theoretical description of the auction. The key difference is that in a traditional English auction, once there are no bidders who wish to raise the price, the auction ends. In an eBay-style auction however, the auction ends at a fixed time, so bidders may play more complex strategies where they wait before raising the bid. This highlights the need in the online auction setting for the sort of identification that is done in Haile and Tamer (2003). A key work in the eBay literature is Bajari and Hortaçsu (2003). They estimate a structural model of eBay auctions and use it to estimate the magnitude of the winner's curse in common value auctions. Additionally, they prove a theorem that with common values, there is a symmetric Nash equilibrium of not bidding until the last minute in order to prevent others from being able to respond to the bid. One of the interesting features of their paper however is that bidders do not actually wait until the end to bid as much as the theorem would suggest. My setting has similar behavior, but I will address it by using a private values assumption avoids the late-bidding equilibrium.

A relevant related literature models mineral auctions with common values. Hendricks, Pinkse, and Porter (2003) study bidding in first price offshore mineral auctions. They find that bidder behavior is consistent with expected bid shading derived in theory. The reason they choose to model mineral auctions with common values is because offshore auctions are a setting where bidders perform seismic surveys to estimate the quantity of oil that can be extracted. Different bidders might get different seismic survey results, so their bids will be

informative to one another, hence a common values modeling. In my onshore setting, the geology is much more well-established and there is not the same amount of information to be gained from competing bidders. Compiani, Haile, and Sant'Anna (2018) prove nonparametric partial identification results in first price auctions with common values, unobserved heterogeneity, and endogenous entry. They apply this to data from first price auctions for offshore mineral rights. Regrettably, their approach cannot be applied to data from English auctions (otherwise I would use it because it contains the trio of things that I would ideally be able to identify together from the bidding data). In fact, Athey and Haile (2002) proves that the Compiani et. al. model cannot be identified using bid data from second price auctions.

The empirical auctions literature is an actively expanding one, with many of the cited papers coming from the last few years. Using some of these novel techniques in an original data setting, I hope to be able to bring a valuable contribution to the literature.

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