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A structural model of competing sellers: Auctions and posted prices

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ABSTRACT

In an original data set of goods listed for sale online, I observe that both auctions and posted prices are popular with buyers and sellers in the compact-disc market. To explain why these two mechanisms coexist, I estimate a structural model of competing sellers who differ in the value of their outside options. Buyers are allowed to value auctioned and posted-price goods differently but the estimated value distributions suggest that differences across buyers do not explain the mechanism coexistence that I observe. In contrast, differences across sellers' outside options are important: the value of the outside option segments the market with high outside-option sellers choosing to post a fixed price. There are two key forces at work that drive this empirical result. First, competition between sellers favors coexistence over an auction-only or a posted-price-only marketplace because sellers prefer to be in a market with fewer rivals. Second, sellers with more valuable outside options prefer the posted-price mechanism because posted-price goods sell less often than auctioned goods but at a higher price. As a result, a larger outside option reduces the loss from not selling and favors the posted-price mechanism.

1. Introduction

Why do we observe goods offered for sale simultaneously using different selling mechanisms? In an original data set of online compact-disc (CD) sales, I observe some sellers auctioning their goods and other sellers posting a fixed price. Numerous papers in the mechanism-design literature show that a seller earns higher expected revenue when selling in an auction. In fact, one can more easily list the papers that do not find the auction to be optimal.[1] Given the wealth of theoretical evidence in favor of the auction mechanism, it is puzzling why any seller with the option to sell in an auction would post a fixed price.

I approach the apparent puzzle of mechanism coexistence in the context of a structural model of competing sellers and find that seller heterogeneity explains why some sellers prefer the auction market and other sellers prefer the posted-price market. Specifically, sellers with more valuable outside options choose to post a fixed price, while sellers with less valuable outside options choose to auction their goods. There are two steps in the logical intuition behind this empirical result. First, why do sellers prefer an environment where auctions and posted prices are both offered (i.e., coexistence) to an environment where all sellers auction their goods? In a standard setting where the auction is revenue dominant, relaxing the common monopolistic-seller assumption can overturn the revenue dominance property. In a marketplace with

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[1] To mention three such papers, posting a fixed price is optimal if the monopolist's capacity exceeds potential demand (Harris and Raviv, 1981), while the posted-price mechanism revenue dominates auctions when buyers' values are highly interdependent (Campbell and Levin, 2006) or are not too dispersed (Wang, 1993).

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numerous competing sellers, an individual seller prefers the market with fewer rivals because the existence of two active markets provides a measure of differentiation that allows sellers to raise expected revenues by softening price competition.

Second, why does the value of the outside option segment the market with high outside-option sellers choosing to post a fixed price? In a marketplace with competing sellers, allowing sellers to differ in the value of their outside options implies that the trade-offs associated with each mechanism changes as the outside option changes. In particular, as the outside option becomes more valuable, the loss from not selling falls. Because the posted-price mechanism earns a higher price but sells less often, a more valuable outside option favors the posted-price mechanism. An increase in the revenue from posting a fixed price relative to auctioning becomes important with competing sellers because it is in a competitive environment that some sellers will choose to post a fixed price to differentiate themselves from their rivals in the auction market.

By focusing on sellers with heterogeneous outside options, I deemphasize buyer heterogeneity. I do though allow the distribution of buyers' willingnesses to pay to differ across mechanisms. While I find that posted-price buyers have higher valuations than auction buyers, the evidence suggests that buyer heterogeneity cannot explain why some goods are auctioned in this marketplace and some goods are sold at a posted price. I also deemphasize the heterogeneity of the goods listed for sale and instead condition on observable heterogeneity within the econometric framework. Preferring an explanation of mechanism coexistence that is based on differences across sellers is consistent with previous findings that seller heterogeneity is more important than buyer or product heterogeneity in explaining the structure of online marketplaces (Zeithammer and Liu, 2006; Hammond, 2010).

Sellers' outside options have not received a great deal of attention in the empirical literature, presumably because the data that are available to empirical researchers rarely contain information on sellers' alternative uses for their goods. That is, we often have data on the "inside" market but not on the "outside" market. The same is true for the data used here. As a result, to show the importance of the outside option in sellers' mechanism choices, I first need to build a framework in which the distribution of outside options is identified. I do so by assuming that sellers are pricing optimally, which allows me to infer sellers' outside options from their pricing decisions. In this way, the distribution of outside options is identified without any assumption on its parametric form. The estimation requires a new structural model where sellers enter either the auction or posted-price mechanism, then make their strategic (reserve or posted) pricing decisions. The structural approach has become increasingly common in the empirical analysis of auction data, beginning with Paarsch (1992) and first used in the context of online auctions by Bajari and Hortacsu (2003).

The intuition of the paper's results is presented in the next section using a simplified example. I then discuss the data and the eBay marketplace from which they are taken. Next, I introduce the structural model to be estimated in Section 4 and the econometric approach in Section 5. Empirical results are followed by a counterfactual analysis of alternative market structures that seeks to explain why posted prices are increasing in popularity online in comparison to the resurgence of auctions that took place following the introduction of online marketplaces such as www.ebay.com.

2. An example on competition and revenue dominance

I present a toy model to illustrate the driving forces at work in the structural model that will be taken to the data. A numerical example demonstrates that competition can break down the revenue-dominance property of the auction mechanism.[2] Further, I discuss the intuition behind the main result of the paper: when sellers prefer an environment where auctions and posted prices are both offered (i.e., coexistence) to an environment where all sellers auction their goods, the value of the outside option segments the market. In particular, sellers whose outside options are low prefer the auction mechanism, while sellers whose outside options are high prefer to post a fixed price.

The following structure is a simplified version of the model of Section 4. There are two buyers and two sellers, where each seller offers a single homogeneous good for sale in either a second-price auction with reserve price r or at a posted price p. For the moment, sellers are assumed to have option options of zero and no costs of participating in either mechanism. Buyers draw their willingness to pay from a uniform distribution on [0,1] and these values are i.i.d. Buyer i receives his value v_i if he obtains either seller's good and, for the moment, let this value be the same irrespective of the seller's mechanism. Sellers simultaneously choose to enter either the auction or posted-price mechanism, then simultaneously set either their reserve or posted price. Buyers simultaneously choose among sellers and, for the moment, let buyers do so using mixed strategies. Instead of formally modeling how buyers arrive at a particular seller in a particular mechanism as a function of prices (as I do in Section 4), here I simply posit that buyers mix equally between sellers with the same price in the same mechanism and buyers mix optimally between sellers in different mechanisms in that the buyer's expected utility from each is equalized. Since buyers are mixing between mechanisms, their expected utility from each mechanism must be equal; equating the two mechanisms' expected utilities allows me to solve for the mixed

[2] The simple model in this section of the paper serves only to build intuition. See the literature on competing mechanism designers for more general models. For example, McAfee (1993) studies large markets as the number of buyers goes to infinity and finds that auctions are optimal, while Peters (1994) finds that the posted-price mechanism is optimal in a model where sellers communicate with buyers sequentially. Further, in Coles and Eeckhout (2003), the all posted-price equilibrium and the all auction equilibrium both exist, though sellers prefer the latter.