Bidding behavior in dynamic auction settings: An empirical analysis of eBay

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A B S T R A C T

We study the impact of dynamic environment of eBay auctions on bidding behavior. Due to high-speed Internet and practically costless search possibilities, bidding behavior is no longer a function of characteristics of a single auction but depends on auctions running simultaneously, completed auctions, available Buy-It-Now prices as well as various outside options. We study how this dynamic market affects a bidder's choice of participating in an auction or leaving eBay for an outside alternative. We analyze Texas Instruments (TI-83) Graphing Calculator auctions presented on eBay. We estimate a random-effects probit model to study bidders' probability of staying in eBay, while controlling for unobservable individual-specific heterogeneity. Our main result shows that *Market Tightness* – the ratio of bidders to sellers – has a negative and significant effect on bidders' decision to remain in eBay. Moreover, variables containing information from other eBay auctions significantly affect bidders' participation decision, thus emphasizing the importance of the dynamic, multi-auction environment in eBay marketplace for potential buyers.

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1. Introduction

Historically, auctions have been one of the most prominent and popular selling mechanisms. In recent years, the pervasive spread of high-speed Internet has led to a significant spurt in on-line trading; Internet auctions are a popular manifestation of this trend. Buyers and sellers can meet in this virtual marketplace to buy and sell a varied range of products without leaving the comfort of their home. The rapid development of this low-cost trading mechanism has thus created an entirely new trading platform.

eBay is the dominant player in this market with net revenues as high as $1.29 billion as of June 30, 2007. Its number of confirmed registered users has grown to 241 million and revenues climbed 26% relative to the corresponding figure the year before.[1] It is therefore not surprising that eBay is one of the most commonly studied online auction mechanisms by academicians. eBay is an ever growing online auction market with items in hundreds of different categories. There are multiple auctions running simultaneously and in most cases, ending sequentially. This huge marketplace offers various alternatives to bidders.

A potential buyer planning on participating in an eBay auction first performs a search for the item she wants to buy. eBay lists current auctions with the early closing ones on top of the screen.[2] These are overlapping auctions that are closing sequentially in a short period of time. Hence, it is appropriate to think of the eBay marketplace as a dynamic environment. The objective of this paper is to highlight the importance of this dynamic environment for bidders' participation decisions on eBay. We utilize the competitiveness of the eBay market as the main focus of our analysis.

Online auctions have received much attention both in Economics and Information Systems literature.[3] These studies have been very valuable in explaining certain peculiar features, such as sniping and the existence of the buy prices, which the standard auction theory cannot explain.[4] However, most of these theoretical studies focus on stand-alone (static) auctions.[5] They explain bidders' optimal bidding strategies, existence of sniping phenomenon and the presence of Buy-It-Now (BIN) prices by mainly focusing on single auctions.

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[1] These numbers are from eBay's announcement of second quarter 2007 financial results.

[2] For instance, for a Texas Instruments (TI-83) calculator, on the first page of the search result, a potential buyer can observe 50 auctions closing in the subsequent 6 h at a single glance. This number holds for an afternoon on a weekday. It might vary depending on the item, day and time.
[3] See Bajari and Hortacsu (2004), Lucking-Reiley (2000), and Pinker et al. (2003) for a comprehensive summary of recent research in economics and information systems.
[4] Sniping is when bidders wait until the very end of the auction to submit their bids and the buy price option gives sellers the opportunity to provide bidders with the possibility of buying the item by paying the price set by the seller prior to the auction. Note that "Buy-It-Now" is the name of the buy price utilized on eBay.
[5] Some of the papers studying static online auctions include Budish and Takeyama (2001), Roth and Ockenfels (2002), Bajari and Hortacsu (2003), Ockenfels and Roth (2006), and Reynolds and Wooders (2009).

Only recently have researchers begun paying more attention to the dynamic environment of online auction mechanisms. Wang (2006) shows that when multiple auctions are present, last-minute bidding exists in the first auction, and it is a unique symmetric sequential equilibrium in undominated, monotone strategies. Similarly, Hendricks et al. (2008) specify an infinite-horizon model in which bidders learn about the number of their rivals rather than about the valuation of the item. The crucial aspect of this model is that bidders have perfect memory and thus can learn from the outcomes of past auctions. The authors show that in equilibrium, buyers always snipe. In another study, Zeithammer (2006) characterizes the eBay environment as an infinite-horizon model of auctions in which bidders are forward-looking and base their actions on information about future auctions. He shows that buyers lower their bids when they expect future auctions offering similar items.

We complement the above-mentioned multi-auction literature by empirically studying the participation decisions of bidders on eBay. In our analysis, we combine the forward-looking bidder behavior as in Zeithammer (2006), with the buyers having perfect memory as in Hendricks et al. (2008). Consequently, we assume that a rational bidder studies both the closed and the upcoming auctions on eBay to learn about the supply and demand side of the market at any point in time. We represent the supply side of eBay with the number of future auctions, and the demand side with the number of losers from previous auctions [*incumbents* as termed by Hendricks et al. (2008)]. Similar to the *market liquidity* used in Kauffman et al. (forthcoming), we employ *Market Tightness* – the ratio of bidders from previous auctions to future sellers – as our main variable of interest. Our key hypothesis is that as the *Market Tightness* increases, potential bidders are discouraged and thus their probability of remaining in eBay decreases.

Apart from the above-mentioned theoretical work on the eBay environment, there is a vast empirical literature on eBay auctions. These papers either test the effect of bidder and auction characteristics on the final selling price or study the effect of bidder and/or seller reputation on bidding behavior (Houser and Wooders 2006, Kauffman and Wood 2005, Kauffman et al. forthcoming, Livingston, 2006, Lucking-Reiley et al. 2007, Melnik and Alm 2002). Similarly, there is a smaller literature that uses data collected via eBay to show the existence of sniping and to study the execution of BIN prices (Ariely et al. forthcoming, Bajari and Hortacsu 2003, Hendricks et al. 2005, 2008; Ockenfels and Roth 2006, Roth and Ockenfels 2002).

Our study differs from the literature mentioned above in a major way. The above literature mainly aims at explaining the existence of sniping among bidders and/or the seller's decision to offer a BIN price. Thus, the emphasis is on the amount and timing of the bids as well as the revenue for the seller. We, instead, study the direct effect of the dynamic eBay environment on bidders' decision to participate in a subsequent auction. Our emphasis is on the bidder's action after not being successful in an auction. To our knowledge, ours is the first study in the literature that studies bidders' participation decisions and how they are affected by the dynamic environment of eBay. In short, our goal is to see if bidders take the market information, such as the competitiveness of the market, into consideration while making their decisions to continue bidding or not. It should be noted that the focus is on actions of bidders after they fail to succeed in an auction since data on non-active potential bidders and the auctions they monitor is not available.

We assume that the bidders are heterogeneous in many respects such as their willingness-to-pay and levels of patience. Most of this heterogeneity is unobservable and thus we use methods to control for it. We estimate a random-effects probit model to study bidders' probability of staying in eBay, while controlling for unobservable individual-specific heterogeneity. In order to demonstrate the existence of information linkages across eBay auctions and the effect of the dynamic environment on the behavior of heterogeneous bidders, we analyze Texas Instruments (TI-83) Graphing Calculator auctions presented on eBay. Our main result reveals that *Market Tightness* has a negative and significant effect on bidders' decision to stay in eBay. Furthermore, we show that this effect has the biggest magnitude among the market-specific variables, which makes it one of the most important factors that bidders consider on eBay.

Additionally, variables containing information from other eBay auctions significantly affect bidders' decisions. More specifically, the number of BIN sellers, the BIN price offered in these auctions, and the winning bid information from the previous auction significantly affects a bidder's participation decision. These findings emphasize the importance of the dynamic, multi-auction environment in eBay marketplace for potential buyers.

More broadly, this study has two main recommendations. Firstly, the significance of the results informs researchers about the importance of treating the eBay environment as a dynamic one rather than a static one. Secondly, the results have key implications for potential sellers on eBay. A strategic and forward-looking seller can time the ending of her auction such that the market is relatively less tight during the last hours of the auction. Consequently, she can have more bidders participating in her auction and thus hope to have higher revenue.

The rest of the paper is organized as follows: in Section 2 we summarize the eBay auction market. Section 3 introduces the dataset we have collected from eBay and offers some summary statistics. In Section 4 we first introduce a new set of variables formed particularly for the analysis and then review the empirical specification. In Section 5 we present our estimation results. Finally, in Section 6, we present our conclusion and suggest future research directions.

2. eBay auctions

eBay auctions are ascending bid auctions. The seller determines the length of the auction which can last for 1, 3, 5, 7 or 10 days.[6] The starting bid is also set by the seller before the auction commences. Any bid below the starting bid is not sufficient for the transaction to go through. The starting bid acts like a posted reserve price for an auction since it is observed by all potential buyers.

In eBay, potential buyers bid by means of proxy bidding. By submitting a proxy bid, the bidder assigns an amount that she is willing to pay for a particular item and eBay's computer runs the bidding on her behalf. If the submitted proxy bid is the highest, then the highest-standing bid is the second-highest proxy bid plus the bid increment.[7] As higher bids get submitted, eBay's computer keeps increasing the highest-standing bid on the bidder's behalf until she is outbid and is no longer the highest bidder. This bidding process continues until the auction ends. The winner is the buyer who submitted the highest proxy bid and pays the second-highest proxy bid plus the bid increment.

At any point in the bidding, the bidders can observe the following information: the highest-standing bid, time left for the auction to close, starting and ending time of the auction, ID of the high bidder including his/her feedback, ID of the seller including his/her feedback along with the percentage of positive feedback, location of the item, shipping and payment details, item specifics including a detailed description with one or more pictures of the item, starting bid, number of bids, quantity being sold and, in most cases, a

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[6] When we were collecting the data, 1-day auctions were not an option for the sellers in eBay.

[7] Bid increment is the lowest amount by which a bidder can raise the highest-standing bid. This number is predetermined by eBay and it depends on the highest-standing bid.