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BUY-IT-NOW OR SNIPE ON EBAY?

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Abstract

In this paper, we study bidder behavior in an eBay auction with a buy-it-now option. The digital environment that eBay provides gives bidders and sellers a variety of options when they participate. These include using sniping software to submit bids at the last minute and hard close times set a priori by the seller (versus Amazon.com's soft close which adds 10 minutes to the end of the auction if there is last minute activity in an auction). Due to the richness of behaviors which can be observed by the bidders participating in eBay, we realize that there are many equilibria for the bidders in eBay. We propose an equilibrium and prove that it is one of the existing equilibria which survives any kind of deviation by the bidders. We analyze this equilibria for the bidders on eBay and validate our model using the data we collected from the Internet.

Introduction

One of the novel ways in which the Internet has impacted the way businesses use dynamic pricing methods involves online auctions. Although merchants have been using auctions to sell their products for centuries, accessibility to this buying mechanism was limited to those who could bear the transaction costs involved in participating in auctions. The selection of products was also limited to unique items in the business-to-consumer (e.g., used cars) or consumer-to-consumer (e.g., antiques) auctions and wholesale or bulk items (e.g., produce, fish, and timber) in the business-to-business auctions. eBay provides a platform to expand this traditional sales channel to the Internet. eBay is currently the dominant player in the United States in the area of consumer-to-consumer online auctions. It uses the Web's unique characteristics such as chat, e-mail, and dynamic content to allow individuals and businesses all around the world to essentially sell anything in this digital flea market. A specific characteristic that we are going to focus on in this paper is the Buy-It-Now (BIN) option for the participants in eBay auctions. This specific tool is solely enabled by the Internet as it did not exist in traditional offline auctions. In this study, we are particularly interested in the impact that the existence of a BIN option has on the frequency of the sniping activity (i.e., last minute bidding) in an eBay auction.

On eBay's site, BIN option for the bidders is explained as follows:

When you see the icon  next to a listing or see a Buy It Now price listed on an item page, you have a special opportunity to get that item right away without waiting for an online auction to end. When it's part of an auction-style listing, the Buy It Now option is only shown on listings until an item receives its first bid, or, for a Reserve Price Auction, when the reserve is met. This means that when you see an item has both a Buy It Now price and a first bid price listed, you will need to act quickly!

It is clear that product type, frequency of purchase, and the tolerance to delay in consuming the product all play an important role in the decision to participate in an online auction and wait, on the average, a week versus executing the buy-it-now option. For sellers, the BIN option is described as follows:

When you choose the Buy It Now option on Online Auction Listings (available for single quantity only), your item has two ways to sell: (1) If a buyer is willing to meet your Buy It Now price before the first bid comes

in, your item sells instantly and your auction ends; (2) if a bid comes in first, the Buy It Now option disappears. Then your auction proceeds normally. (In Reserve Price Auctions, Buy It Now disappears after the first bid that meets the reserve.)

Thus, for sellers, the BIN option provides a signal to bidders what the ceiling price is. This option costs the seller 5 cents to add to his/her auction. Figure 1 provides screenshots from eBay's standard auctions with BIN options.

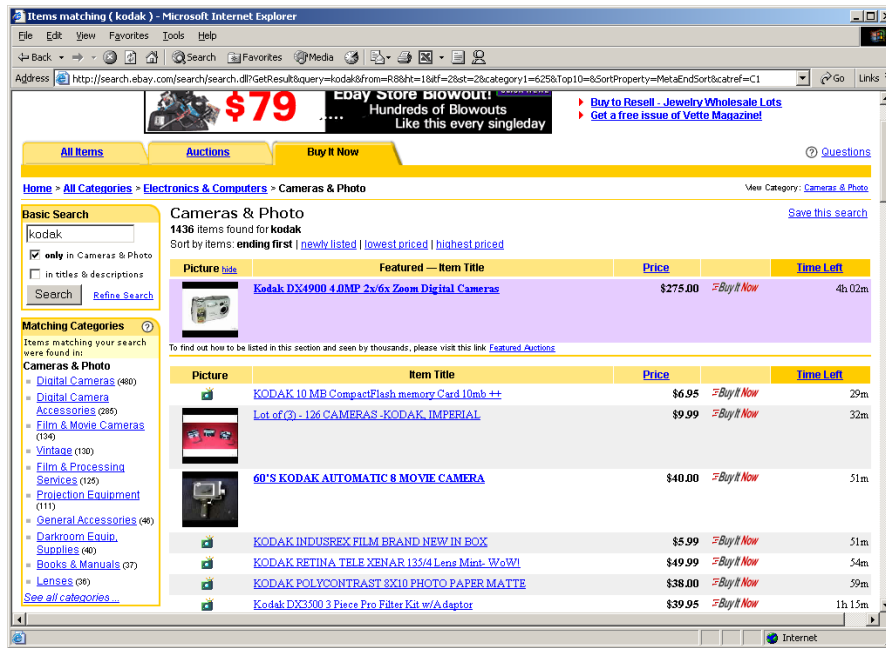


Figure 1. eBay Auctions for Kodak Digital Cameras with Buy-It-Now Options

Traditionally, auctions were used to sell goods for which market prices are hard to determine. Either the seller, the buyer, or both were uninformed about the actual value of the product. For the last few years, auctions have been used to trade a multitude of goods over computer networks and the Internet. The goods are not only physical products but intangible products like computer and network resources (Lazar and Semret 1998), negotiation between software agents (Sandholm 1999), etc. Auction research is an extensively studied area with a large number of papers focusing on the efficiency and optimality of auctions with different characteristics. Comprehensive surveys can be found in McAfee and McMillan (1987) and in Milgrom (1989).

Recently, Lucking-Reiley et al. (2000) studied online auctions for collectible one-cent coins at eBay.com. They found that a seller's feedback rating, reported by eBay buyers, had a significant effect on auction prices. Furthermore, minimum bids and reserve prices tend to have positive effects on the final auction price. On average, the length of the auction also has a positive impact on the auction price. In another significant paper, Lucking-Reiley (1999) tests the revenue equivalence of different types of auctions on the Internet. One of the most important findings in this paper is that despite the fact that at least one of the theory's assumptions fails to hold, the data support a number of predictions of the theory including the strategic behavior of the bidders. Bajari and Hortacsu (2000) measure the extent of the winner's curse in online auctions. They find that a bidder's expected profits fall when the expected number of bidders increases at the margin.

Along with these empirical attempts to understand the structure of online auctions, various papers model consumer and/or seller behavior online. Vakrat and Seidmann (1999) study the impact of bidders' arrival process on the design of online auctions and find that most bidders like to sign on early in the auction. They also find that the minimum initial bid is negatively correlated with the number of bidders per auction while the number of units offered and the length of the auction is positively correlated with the number of bidders. Increased dispersion in the bidders' values may either increase or decrease the auction price depending on the bidders' overall arrival process, the length of the auction, and the number of units. Vakrat and Seidmann (2000) compare online auctions to online catalogs and find that auction winners have an average discount of 25 percent compared to the catalog prices for identical items sold at the same site. Vakrat and Seidmann (1999, 2000) focus on the price dispersion between the two channels

only. They analyze the effect of learning the price of a product in an online catalog and then participating in the corresponding online auction. Thus the expected winning bid is a function of the posted price.

There are three significant works to mention about buy prices mainly on Yahoo and eBay. The first one is a study by Budish and Takeyama (2001). They examine the issue of buy prices in online auction sites like Yahoo and Amazon.com and show that it makes sense for a seller to use a buy price while designing the auction when there are risk-averse bidders. Reynolds and Wooders (2002) characterize unique symmetric equilibrium strategies for risk neutral bidders in both eBay and Yahoo auctions. They also show that expected seller revenue for eBay auctions is less than what sellers get in Yahoo when buy price is executed. Hidvegi et al. (2002) concentrate on the value of the buy price option only for Yahoo auctions. They specify an equilibrium strategy and show that when both sellers and buyers are risk-neutral, then the revenue equivalence theorem holds. On the other hand, with risk-averse bidders or sellers, expected utility of the seller can be increased if buy price option is exercised.

In this paper, we address the following research questions.

1. When would a bidder execute the BIN option?
2. What is the impact of the BIN option on a bidder’s sniping decision?

We find that if there are bidders with asymmetric valuations, the low-valuation bidder always chooses to wait and snipe toward the end of the auction and the high-valuation bidder chooses to execute the BIN option at the initial stage of the auction. If there is a successful bid by the other buyer and it is recorded prior to the execution of the BIN option, we show that it is optimal for the high bidder to snipe.

Overview of the Model

eBay auctions are ascending second-price auctions where the winner is the highest bidder but pays the second highest bid plus a small increment. All bids in eBay are proxy bids, which means a bidder bids the amount s/he is willing to pay for the item and eBay’s back-end system runs the incremental bidding for the bidder as long as s/he is the highest bidder. eBay auctions are all hard-close auctions, which means that the auction ends at a predetermined time chosen by the seller, without any extensions. This is unlike Amazon auctions where the ending time of the auction is extended until there is a 10-minute interval when no bids arrive.

Roth and Ockenfels (2002) show that in eBay auctions, most of the bids are submitted close to the end of the auction due to the hard-close property of eBay. This outcome is one of the many existing equilibria. The aim of this paper is to take the auction theory one step closer to real life and model the eBay auctions with BIN option while keeping this hard-close property in mind. We will show that a new equilibrium exists for this type of auction and examine under which conditions this equilibrium survives. We then analyze the equilibrium without the BIN option and see what additional gains are attained by having the BIN option. Since the main goal of the BIN option is to get a bidding war started as soon as possible, it may be the case that the equilibrium where everybody bids at the last minute will not survive. The model is based on an independent private values (IPV) environment where a single item is being sold to many bidders by a single seller.

We start with the most basic case where there are only two types of bidders; high and low value. These are buyers who have high and low (H and L) valuations for the item on which they are bidding. To keep it simple, we assume there is only one seller and there is a single item that is up for sale. We use the following notation in our model:

Notation	
R	The reserve price
ϵ	The minimum increment for the bid
P	The probability that a last-minute bid will be recorded
V	Bidders’ value for the item
B	Buy-It-Now price

Assume that $P < 1$, $L < B$, $H > B$, $L > R + \epsilon$ and $V_i = \{L \text{ with probability } \frac{1}{2}, H \text{ with probability } \frac{1}{2}\}$ where i indexes the bidder.

The strategy set for the game is as follows. Strategy {BIN} represents executing the BIN option, {W} stands for bidding the reserve price (R) at the beginning of the auction and then waiting until the end of the auction to bid own valuation at the last minute (sniping), and {A} stands for starting the auction by bidding own valuation.

There are three stages to this game where bidders need to choose a strategy. We present the timeline in Figure 2.

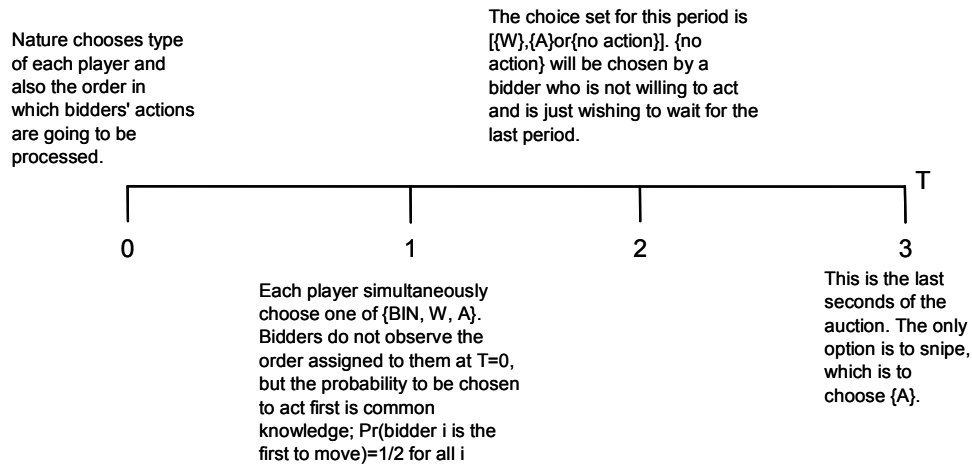


Figure 2. Timeline of Auction Strategies

Our assumption is that every bidder in the last period has only one chance to submit a bid and P is the probability that the bid will be recorded. Considering the congestion problems bidders face in the last minutes of the auction due to the hard-close property, it is realistic to set $P < 1$. Thus, when a bidder decides to snipe, there is a chance s/he might not get the item but, on the other hand, there is also the chance that s/he might get it for only R . Prior to the last period, many bids can be submitted and they are recorded with probability one. Following Roth and Ockenfels' (2002) definition of {W}, if a bidder chooses this option, s/he bids R and then starts to wait hoping to snipe. If s/he sees the high-standing bid and it is $R + \epsilon$, then s/he bids her/his own valuation since {A} is a best response when s/he observes that the other bidder submitted her/his own valuation and s/he is not willing to wait for the last minute to snipe.

Analysis and Preliminary Results

Due to many options which lead to various auctions with minor differences, there are multiple Nash equilibria in this game and the most obvious one is where each player bids her/his own value of the item at the beginning and waits for the auction to end. This is the most common and trivial equilibrium for second-price auctions in the IPV environment. However, there are other Nash equilibria and we show one of the more complex ones in this paper. The following is the equilibrium we propose:

The low-value bidder always chooses to wait and snipe toward the end of the auction and the high-value bidder chooses to execute the BIN option at the initial stage of the auction. If there is a successful bid recorded prior to the execution of the BIN option, we show that it is optimal for the high-value bidder to submit her/his own value.

We posit that the equilibrium we proposed is a symmetric Nash equilibrium and no bidder has an incentive to deviate given that the other player plays the proposed equilibrium. We show the proof in three steps. First, we prove that for the low-value bidder it is always optimal to choose {W} no matter whom s/he is playing against. Then, in the second step, we show that if {BIN}, the action taken by the high-type bidder, is not successful, s/he proceeds with choosing {A}. In the final step, we show that no bidder has an incentive to deviate from the proposed equilibrium.

Proposition: For low value bidders choosing {W} is a symmetric Nash equilibrium.

Proof. (Sketch of Proof) Considering the assumptions we have made earlier, it is easy to show that the low-value bidder will never go for {BIN} because if s/he wins the auction s/he gets a negative payoff of $(L - B) < 0$. Thus, choosing {W} and {A} strongly dominates choosing {BIN}. And the low-value bidder always chooses {W} over {A} since s/he knows by choosing {W} s/he can earn a higher expected payoff by just bidding R and sniping at the last minute, rather than bidding {A}, which means s/he increases the high-standing bid up to $R + \epsilon$ and starts a bidding war, i.e., everyone bids {A} and since s/he is the low-value bidder s/he always gets zero payoffs.

Proposition: *Given that the high-value bidder's action of {BIN} has not been successful, optimal strategy at $T = 2$ is to choose {A}.*

Proof. (Sketch of Proof) Our proposed equilibrium is for the high-type bidder to play {BIN} and for the low-type bidder to play {W} at $T=1$. Thus, if the high-type bidder's action is not recorded and the game is still on, s/he knows that the probability s/he is playing against another high-type is zero because if the other bidder was a high-type then s/he would be awarded the item and the game would be over. Therefore, the high-type bidder who couldn't succeed in her/his first action knows that s/he is facing a low-type bidder. Given this information, it is straightforward to show that high-type bidder would prefer to choose {A}, win the item for sure, and earn positive payoffs rather than choosing {W} and face the probability of not winning and leaving the auction without the item.

Discussion and Future Extensions

We presented the initial solution of our model and some empirical observations using the preliminary data we collected from eBay. Figure 3 is constructed using data collected for Kodak digital cameras. BIN auctions are the winning bid submission times for auctions that had the BIN option available at the beginning but then the option disappeared due to a buyer bidding the reserve price. No-BIN auctions are the winning bid submission times for auctions that did not have a BIN option at all. We had 14 BIN auctions and 184 No-BIN auctions in total. Figure 3 presents the validity of our first Proposition. When there is no BIN option available, bidders tend to wait until the last minute and snipe, which is the equilibrium proposed by Roth and Ockenfels (2002). More interestingly, we observe that when there is a BIN option and it is not exercised, bidders are inclined to bid their valuations by choosing {A} rather than sniping. These findings provide support for our theoretical proposition.

We are currently in the process of collecting more data on different types of items in addition to items with various bidder valuations in order to compare high- and low-value items as well as independent and common-value auction environments. We will report on the outcome of our data analysis with the larger data set as well as refinements of our model at the conference.

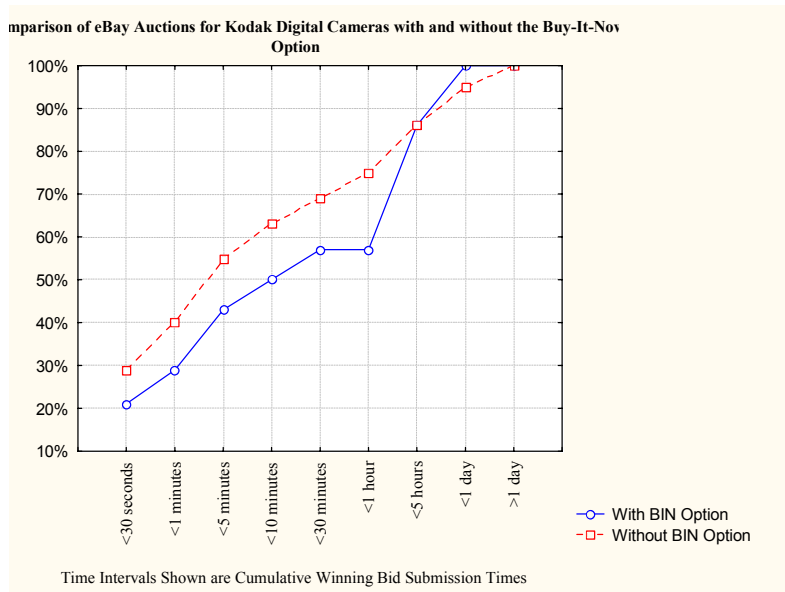


Figure 3. Comparison of eBay Auctions for Kodak Digital Cameras with and Without the Buy-It-Now Option

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