Sniping to Avoid the Endowment Effect in Auctions

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Abstract

An endowment effect can result in both multiple bidding and sniping in auctions. It can cause players to bid multiple times and overpay for items. Sniping is a rational response for experienced bidders looking to avoid the endowment effect.

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Introduction

In online auctions on eBay and Amazon.com, some bidders increase their bids over the course of an auction (commonly called *multiple bidding*), others wait until the closing moments of an auction to bid (commonly called *sniping*) (Roth and Ockenfels 2002, Ariely et al. 2005). Such behavior is inconsistent with standard auction models.

This paper formally incorporates a simple model of an "endowment effect" into a private-value, second-price auction and shows how it leads to both multiple bidding and sniping. The term endowment effect describes the tendency of people to value a good more when they think of it as their own (Thaler 1980). In an auction, this means that a player's willingness to pay for an item depends on whether he expects to win the auction (Heyman et al. 2004).[1] Although other papers suggest that the endowment effect causes multiple bidding, we are the first to show it may also cause sniping.[2]

It is relatively straightforward to see how the endowment effect may result in multiple bidding. the endowment effect may cause an early bidder to increase his valuation. He may then increase his bid (thus engaging in multiple bidding).

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[1]The endowment effect has been widely documented in the literature (e.g., Kahneman et al. 1990). We use the term endowment effect to refer to the effect both when ownership is firmly established and when ownership is expected (e.g., what (Heyman et al. 2004) refer to as a "quasi-endowment" effect).

[2]Other explanations for multiple bidding include bidders learning about valuations for an object over time (Cotton 2009, Hossain 2008, Rasmusen 2006), or bidders not understanding the bidding mechanism (Roth and Ockenfels 2002). Bajari and Hortacsu (2004) review possible explanations of sniping, including the presence of asymmetrically informed bidders (e.g., Wilson 1977), sequential auctions (Ely and Hossain 2009), tacit collusion among bidders (Roth and Ockenfels 2002), or bidders who do not understand the bidding mechanism (Ockenfels and Roth 2006).

The contribution of this paper is to show how the endowment effect can also drive sniping. The intuition is as follows. From an ex ante perspective, players want to avoid the endowment effect, as it can result in them increasing their bids above their initial valuations. By sniping, bidders effectively commit to providing only one bid in the auction (at their initial valuation), and eliminate the threat posed by the endowment effect.[3] As long as the costs of waiting to bid are not too large, sophisticated bidders (e.g., those who know they are susceptible to the endowment effect) snipe. Naïve bidders (e.g., those who do not know they're susceptible), on the other hand, bid early and possibly multiple times. The results are consistent with the empirical evidence that experienced bidders are more likely to snipe, while less-experienced bidders are more likely to engage in multiple bidding (e.g., Roth and Ockenfels 2002).

We illustrate how the endowment effect may cause sniping using a simple model. The intuition should continue to hold in a more-general framework. For example, there may be more than two bidders, auction may lasts for more than two periods, or not all players may be susceptible to the endowment effect. We expect that the intuition from the model would also continue to hold with a more general model of reference dependent preferences (e.g., Koszegi and Rabin 2006). Of course, any of these generalizations may put further restrictions on the parameter space for which both multiple bidding and sniping coexist in equilibrium. Additionally, the intuition will continue to hold if (instead of suffering from the endowment effect) players may "get caught up in" the bidding process; by sniping, a player avoids getting caught up in a bidding war.

Model

There are two bidders in a second-price, winner-pay auction that lasts for two periods. Bidder i values the auctioned item at $v_i \geq 0$, which is the independent realization of a random variable with smooth distribution F and density f, where $f(v_i) > 0$ if and only if $v_i \in [0, \bar{v}]$. Bidder i knows v_i and F, but not v_{-i}.[4]

There are two periods in which one may bid. Denote agent i's first period bid $B1_i > 0$, and denote his second period bid $B2_i \geq B1_i$. If i does not bid in period 1, by default $B1_i = 0$. If he does not bid in period 2, by default $B2_i = B1_i$. In period 2, an agent can increase his bid or leave it unchanged, but he cannot decrease his earlier bid. The agent with the highest $B2_i$ (i.e., the high bidder) wins the prize and pays a price equal to $B2_{-i}$. In a tie, each agent wins with probability $1/2$; unless the tie is at $B2_1 = B2_2 = 0$, in which case neither agent wins the prize.

All players can submit a bid in period 1. However, they may not be able to submit a bid in period 2. Let $1 - \alpha \in (0, 1)$ denote the probability an agent is able submit a second period bid. When choosing $B1_i$, agent i does not know whether he will be able to bid in period 2; although he knows α.[5]

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[3]This is similar to commitment devises used to deal with other self-control issues such as present-biased preferences. O'Donoghue and Rabin (1999) argue that sophisticated agents may limit their future choice sets when they know their future selves could act in a way that reduces long-run welfare (from the current-period perspective).

[4]Subscript $-i$ denotes i's opponent.

[5]There are many reasons why $\alpha > 0$ is reasonable. It represents the possibility that something comes up resulting

Players experience an endowment effect if they are the high-bidder in period 1; that is if $B1_i \geq B1_{-i}$, and $B1_i \neq 0$. Consistent with the behavioral literature, we formally model the endowment effect as a form of loss aversion. If player i experiences the effect but does not eventually win the item, he experiences a cost $-\tau$ where $\tau > 0$.

Although all players are susceptible to the endowment effect, not all players are aware of this tendency. With probability $\mu \in (0, 1)$, a player is unaware of the endowment effect.[6] Such a *naïve* player chooses his initial bid unaware that any player may experience the endowment effect (i.e., as if $\tau = 0$). With probability $1 - \mu$, a player is *sophisticated* and aware of the endowment effect. Such a player takes both τ and μ into consideration when choosing his bids. This assumption is consistent with the idea that experienced bidders may be more likely to recognize their tendency to experience the endowment effect, while less-experienced bidders may not realized that such a tendency exists.

When player i wins the item, he realizes payoff $U_i = v_i - B2_{-i}$. When he does not win the auction, he experiences payoff $U_i = 0$ if he was never the high bidder, and payoff $U_i = -\tau$ if he experienced the endowment effect.

Player i is said to *snipe* if he waits to submit his first bid until the second period; that is, if $B1_i = 0$ and, when he can bid in the second period, $B2_i > 0$. A player is said to engage in *multiple bidding* if he bids in the first period, then raises his bid in the second period; that is, if $B1_i > 0$ and, when he can bid in the second period, $B2_i > B1_i$.

Equilibrium

Using backward induction, the analysis solves for the perfect Bayesian equilibrium (PBE) of the auction game.[7]

Period 2

Period 2 of the auction takes the form of a traditional Vickrey second-price auction, where all bidders submit their (updated) valuations. If player i can submit a bid in the second period, in equilibrium he submits $B2_i = V_i$ if he did not experience the endowment effect in period 1, and he submits $B2_i = V_i + \tau$ if he did experience the endowment effect.

Period 1: naïve players

Naïve players believe they are bidding in an auction in which all players are fully rational, including themselves. They play the equilibrium strategies from such a fully-rational game, and bid their valuation in period 1. That is, for naïve bidders, $B1_i = v_i$. If $B1_i > v_i$, then he may end up paying

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in the opportunity cost of returning to the auction being higher than the expected benefit of returning, or that the bidder has technical issues connecting to an online auction or submitting a bid.

[6]For a formal consideration of unawareness, see Dekel et al. (1998).

[7]Formally, the description of a PBE requires a definition of the beliefs. We generally ignore the beliefs in the paper, as they should be obvious from the analysis, and off-equilibrium-path beliefs do not affect play.

more than his valuation for the item. If $B1_i < v_i$ (including $B1_i = 0$), then he may not win the item, even when it sells for less than his valuation. In either case, a naïve player has an incentive to bid his valuation in the first period.

Period 1: sophisticated players

Suppose player i is sophisticated. He knows that bidding in period 1 can result in him becoming attached to the item and experiencing the endowment effect. By waiting to submit his first bid until period 2, a player can effectively commit to submit only one bid in the auction. This eliminates the possibility that one experiences the endowment effect, which may result in him increasing his bid and paying more than his valuation for the item, or in him not winning the item and experiencing loss $-\tau$. This is the benefit of sniping.

However, sniping also comes with some costs. First, with probability α one is unable to submit a bid in the second period. If a player does not bid in the first period, the auction may end without him submitting a bid. In this case, he does not win the item, even if the other player didn't bid or bid less than his valuation. Second, waiting to bid increases the likelihood that an opponent experiences the endowment effect in period 1. This in turn increases the opponent's expected bid, which decreases the probability one wins the item when competing against the opponent, and increases the expected price one must pay if he does win the item. These are the costs of sniping.

Whether a sophisticated agent snipes in equilibrium depends on the relative benefits and costs of doing so. The main result of the paper says that when the costs are not too large, sophisticated players snipe, while naïve players increase their bids over the course of the auction.

Proposition 1 *There exists a pure-strategy perfect Bayesian equilibrium in which naïve players engage in multiple bidding, and, when α and μ are not too large, sophisticated players snipe.*

The parameter α is the probability one cannot submit a second period bid, and μ is the probability one's opponent is naïve. When naïve players bid early and sophisticated bidders snipe, α and μ represent the costs associated with sniping. When the costs are small enough, sophisticated players snipe. When the costs are too large, the sophisticated players bid in the first period.

The analysis implies the following testable result.[8]

Corollary 2 *If sophistication is positively correlated with experience, then sniping increases with experience, and multiple bidding decreases with experience.*

There is ample evidence in the empirical literature that this is true. Ockenfels and Roth (2006) present field evidence from eBay auctions that support this result. Ariely et al. (2005) present similar evidence from lab experiments.[9]

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[8] A formal proof is omitted, as it follows from the earlier analysis.

[9] Both Ockenfels and Roth (2006) and Ariely et al. (2005) also present evidence that sniping is more common in eBay auctions than in Amazon.com auctions. The endowment effect model is also consistent with this evidence. Where an eBay auction ends at a fixed point in time, an Amazon.com auction is extended when someone submits a bid near the end of the auction. This means that sniping to avoid the endowment effect only works in eBay auctions.

Proof to Proposition 1

From the analysis in Section , we know that for naïve players, $B1_i = v_i$, and $B2_i = v_i + \tau$ if $B1_i \geq B1_{-i}$ and $B2_i = v_i$ if $B1_i < B1_{-i}$. A naïve player bids in the first period, then if he experiences the endowment effect, he attempts to increase his bid in the second period. That is, naïve players engage in multiple bidding. This is always true.

It remains to be shown that there exists an equilibrium in which sophisticated bidders snipe when α and μ are low enough. It is straightforward to show that if i submits the high bid in period 1 and can submit a bid in period 2, then $B2_i = v_i + \tau$; also, if he does not bid in period 1, he prefers $B2_i = v_i$. Given this, if i chooses not to snipe, then he chooses $B1_i > 0$ to maximize

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\begin{aligned}
&\mu \int_0^{B1_i} f(v_{-i})[v_i - v_{-i}]dv_{-i} + (1-\mu)(1-\alpha)^2 \left(\int_0^{v_i+\tau} f(v_{-i})(v_i - v_{-i})dv_{-i} - (1 - F(v_i+\tau))\tau \right) \\
&+ (1-\mu)\alpha v_i + (1-\mu)\alpha(1-\alpha) \left(\int_0^{B1_i} f(v_{-i})[v_i - v_{-i}]dv_{-i} - (1 - F(B1_i))\tau \right).
\end{aligned}
\tag{1}
$$

From the first order conditions,

$$
B1_i^* = v_i + \frac{(1-\mu)\alpha(1-\alpha)}{\mu + (1-\mu)\alpha(1-\alpha)}\tau.
$$

Plugging $B1_i^*$ into Eq. 1 gives the maximum expected utility if i does not snipe, which we denote $EU_i(B1_i > 0)$. If he instead chooses to snipe, he expects

$$
\begin{aligned}
EU_i(B1_i = 0) = \quad & (1-\mu)(1-\alpha)^2 \int_0^{v_i} f(v_{-i})(v_i - v_{-i})dv_{-i} + (1-\mu)(1-\alpha)\alpha v_i \\
& + \mu(1-\alpha)\alpha \int_0^{v_i} f(v_{-i})[v_i - v_{-i}]dv_{-i} + \mu(1-\alpha)^2 \int_0^{v_i-\tau} f(v_{-i})(v_i - v_{-i} - \tau)dv_{-i}.
\end{aligned}
$$

Both $EU_i(B1_i > 0)$, and $EU_i(B1_i = 0)$ are continuous functions in α and μ. Therefore, to show that sophisticated bidders snipe when α and μ are small enough, it is sufficient to show that for any $v_i \in [0, \bar{v}]$, $EU_i(B1_i = 0) - EU_i(B1_i > 0) > 0$ when evaluated as $\alpha \to 0$ and $\mu \to 0$. The condition simplifies to

$$
\left[\int_0^{v_i} f(v_{-i})(v_i - v_{-i})dv_{-i} \right] - \left[\int_0^{v_i+\tau} f(v_{-i})(v_i - v_{-i})dv_{-i} - (1 - F(v_i+\tau))\tau \right] > 0.
$$

Since $\int_0^{v_i} f(v_{-i})(v_i - v_{-i})dv_{-i} > \int_0^{v_i+\tau} f(v_{-i})(v_i - v_{-i})dv_{-i}$ the requirement is met. The strict inequality implies a positive range of values α and μ such that the condition still holds. For small enough α and μ, sophisticated bidders snipe.

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