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Abstract

A lowest unique bid auction allocates a good to the agent who submits the lowest bid that is not matched by any other bid. This peculiar auction format is getting increasingly popular over the internet. We show that such a selling mechanism is unprofitable if bidders are rational but can become highly lucrative if bidders are myopic. In this second case, we analyze the key role played by the existence of some private signals that the seller sends to the bidders. Data about actual auctions confirm the profitability of the mechanism and the bounded rationality of the bidders.

KEYWORDS: Lowest Unique Bid Auctions, Signals, Bounded Rationality.

JEL CLASSIFICATION: D44, C72, D82.

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1 Introduction

A new wave of websites is seducing consumers over the internet. These websites sell goods of considerable value (electronic equipment, watches, holidays and even cars and houses) through quite a peculiar auction mechanism: the winner is the bidder who submits the lowest *unique* offer, i.e., the lowest offer that is not matched by any other bid. Such a mechanism, that is commonly labelled as lowest unique bid auction, leads to impressively low selling prices: browsing the list of closed auctions of one of these websites one finds that an Ipod (value 200 euros) has been sold for 0.25 euros, a Sony Playstation 3 (400 euros) for 1.76 euros and a new Volkswagen Beetle Cabriolet (32.000 euros) for 32,83 euros. These are not exceptions: as a rule of thumb, objects are usually sold for a price that is in the order of 0.1% of the market value.

Websites offering these auctions first appeared in Scandinavian countries in early 2006. Since then, they rapidly developed in many other European countries (France, Germany, Holland, Italy, Spain, UK).¹ Word of mouth is fast and this selling mechanism is gaining increasing media attention: there are flaming discussions in the blogosphere but also proper articles in major newspapers. Some people say it is a game of strategy, some say it is just a lottery, some suspect it is a plain scam. In this paper we contribute to this debate by studying this auction format from a game theoretic point of view. We show that the auctioneer's expected profits would be negative if consumers were fully rational. As a consequence, auctions of this kind should not even take place, a prediction which is clearly at odds with what we observe in reality. We then adopt a more behavioral approach and show how these auctions, by exploiting consumers' myopia, turn out to be highly profitable. Finally, we analyze some data about actual auctions. The data confirm the profitability of this selling mechanism and the limited rationality of the bidders.

But before moving to the proper analysis let us introduce the auction format in more detail. As a first step, agents must register to one of these websites and

¹Here is a far from exhaustive list of some of these websites: bidster.com (Scandinavian Countries); youbid.fr, bidcrown.fr, mamabid.com (France); auktionclick.com, betsmart.eu (Germany); bidster.com (Holland); bidplaza.it, bidandgo.com, lowbid.it (Italy); pujamasbajo.com, subin.es, menudapuja.com (Spain); bidplaza.uk, bidlowest2win.com, bidster.com (UK).

transfer an amount of money of their choice to a personal deposit.² Users can then browse through the objects on sale and submit as many bids as they want on the objects of their choice. Bids are expressed in cents and are private information. Every time that a user places a bid a fixed amount of money (typically 1 or 2 euros) is deducted from his deposit. The auctioneer justifies this cost as a price for a (compulsory) “packet of information” that he sends to the bidder. In fact, as soon as a bid is submitted, the user gets one of the three following messages: 1) Your bid is currently the unique lowest bid; 2) Your bid is unique but is not the lowest; 3) Your bid is not unique. During the bidding period, which usually lasts for a few days, users can at any time log in to their account in order to check the current status of their bids, add new ones or refill the deposit. Once that the auction closes, the object is sold to the bidder who submitted the lowest unique bid. For instance, if agents A and B offer 1 cent, C offers 2 cents, A and D offer 3 cents and E offers 6 cents, the object is sold to C for a price of 2 cents.

This allocation mechanism is therefore considerably different with respect to traditional auction mechanisms.³ In particular, it is the requirement about the uniqueness of the winning bid that represents a novelty. On one hand, this requirement undermines key objectives that lie at the core of standard auction theory, like for instance the efficiency of the final allocation. On the other hand, it adds some new strategic elements. Indeed, from a strategic point of view, a lowest unique bid auction is more similar to other well known games. For instance, given that agents want to outguess the rivals, the game has something in common with a Guessing Game (Nagel, 1995). There is an important difference though. In the Guessing Game the pattern of best responses follows a unique direction. This does not happen in a lowest unique bid auction. In fact, a player that expects all the opponents to bid 1 cent maximizes his payoff by bidding 2 cents. But if the player expects all the opponents to bid 2 cents then he should switch back and bid 1 cent. Therefore, the game is not dominance solvable. On the other hand, some other features of

²The registration is for free but users must provide quite detailed personal data (name, address, e-mail, phone number).

³Detailed reviews about the rich auction theory literature can be found in Klemperer (1999) or Krishna (2002).

the game (possibility of multiple bidding, fixed cost for each bid and instantaneous knowledge of the bids' status) makes it similar to a War of Attrition (Maynard Smith, 1974). But certainly the closest relative of the lowest unique bid auction is the Dollar Auction Game (Shubik, 1971). This is a public auction in which the prize (say, one dollar) is won by the highest bidder but both him and the second highest bidder must pay their bids. When participants are not fully rational this game can lead to some paradoxical results that highly reward the auctioneer. We will see that something analogous can easily happen in the case of lowest unique bid auctions.

Apart from these classical contributions, there are also some very recent papers that explicitly consider various versions of unique bid auctions. Eichberger and Vinogradov (2007) analyze what they call LUPA (Least Unmatched Price Auctions): N bidders simultaneously submit multiple bids, there is a fixed cost for each bid and the good is sold to the agent who submits the lowest unique bid. They show that the game has a unique Nash equilibrium in which agents mix over bidding strategies characterized by full support (i.e., bidding strings comprise the minimum allowed bid and are made of consecutive numbers) and decreasing probabilities (i.e., lower numbers are chosen with higher frequency).⁴ Östling *et al.* (2007) study a LUPI (Lowest Unique Positive Integer) game. In their model the number of participants follows a Poisson distribution, players can submit only one bid and they do not have to pay any fee. They also find a symmetric mixed equilibrium characterized by decreasing bidding probabilities. They then depart from the assumption of perfect rationality by exploring a model of cognitive hierarchy with quantal response. Finally, Rapoport *et al.* (2007) analyze unique (lowest and highest) bid auctions where players submit a unique bid, there are no entry costs and the winner wins his bid such that the prize is endogenously determined. In this case bids do not necessarily follow a monotonic probability distribution. In addition to the theoretical analysis all these papers also have an empirical part that uses field and/or experimental data. Predictions of the models find some empirical evidence at the aggregate level but a much lower one at the individual level.

⁴Similarly, Raviv and Virag (2007) study an auction in which the highest unique bid wins and show that in equilibrium higher numbers are chosen with higher probability.

With respect to this ongoing literature our paper differs in many ways. First, we try to match as closely as possible the rules implemented in reality. In particular, not only we consider entry fees and the possibility of multiple bids (as in Eichberger and Vinogradov, 2007), but we explicitly analyze the role of the signals that the seller sends to the bidders. We show these signals to be a key element of the mechanism, especially for what concerns out of equilibrium play. Second, we adopt a more general approach. In fact, our paper studies a sequential game in which the behaviors of both the bidders and the auctioneer are modelled. It is thanks to this broader point of view that we can claim that no lowest unique bid auction should be observed if players were fully rational. Third, we investigate which are the features of the mechanism and the behavioral biases of the bidders that on the contrary make this auction format so successful. Finally, we are the first ones to recognize the link between lowest unique bid auctions and the Dollar Auction Game.

The remaining of the paper is organized as follows: Section 2 formalizes the strategic situation and characterizes its equilibria under the assumption of perfect rationality of the players. Section 3 investigates what happens in the more realistic situation of boundedly rational bidders. Section 4 examines a dataset which collects detailed information about 100 auctions. Section 5 concludes.

2 The game and its equilibria

We introduce and analyze a sequential game that captures the key features of a lowest unique bid auction. The game has three players: a seller (S) and two symmetric potential buyers (A and B).⁵ The seller, whose outside option is $u_S = 0$, can decide to auction a good of common value K . If S opens the auction he credibly commits to sell the good to the buyer $i \in \{A, B\}$ who offers the lowest positive price that is not matched by any other bid. Time is discrete and runs from $t = 1$ (the opening of the auction) to $t = T$ (the closing of the auction). At any period $t \in \{1, \dots, T\}$ players A

⁵In real auctions bidders are likely to be many more than two. Still no agent knows the number of participants such that each bidder can see himself as facing a unique fictitious player that collects all the rivals.

and B have the possibility to submit a bid.⁶ Bidders must pay to the seller a fixed amount $c \in (1, K - 1]$ for every bid they submit. We indicate the strategy space of bidder i with $S_i = \{x_i^t\}_{t=1}^T$ with $x_i^t \in \{\phi \cup \{1, \dots, \infty\}\}$. Action $x_i^t = \phi$ indicates that agent i does not bid at period t such that strategy $s_i = \{\phi\}_{t=1}^T$ means that player i does not enter the auction. Action $x_i^t \neq \phi$ indicates that agent i submits at time t the bid $x_i^t \in \{1, \dots, \infty\}$. Players cannot renege on previous bids such that $\{x_i^t \mid x_i^t \neq \phi\}_{t=1}^{t^*} \subseteq \{x_i^t \mid x_i^t \neq \phi\}_{t=1}^{t^*+1}$. For instance if $x_i^1 = 1$, $x_i^2 = 3$ and $x_i^3 = \phi$ then $\{x_i^t \mid x_i^t \neq \phi\}_{t=1}^1 = \{1\}$ and $\{x_i^t \mid x_i^t \neq \phi\}_{t=1}^2 = \{x_i^t \mid x_i^t \neq \phi\}_{t=1}^3 = \{1, 3\}$. All the monetary values that appear in the game $(K, c$ and $\{x_i^t\}_{t=1}^T)$ are expressed in the same unit (say euro cents).

As soon as player i places a bid $x_i^t \neq \phi$ he, and only he, receives a truthful signal from the auctioneer $\sigma(x_i^t) \in \{Y, M, N\}$. It is common knowledge that the signals mean the following:

- $\sigma(x_i^t) = Y$ indicates that x_i^t is currently the lowest unique bid.
- $\sigma(x_i^t) = M$ indicates that x_i^t is a unique bid but is not the lowest.
- $\sigma(x_i^t) = N$ indicates that x_i^t is not a unique bid.⁷

The status of some bids can thus change over the course of the auction. In particular the signal $\sigma(x_i^t) = Y$ can be updated by $\sigma'(x_i^t) = M$ or $\sigma'(x_i^t) = N$ while the signal $\sigma(x_i^t) = M$ can be updated by $\sigma'(x_i^t) = Y$ or $\sigma'(x_i^t) = N$. Bidders can check the current status of their bids at any time and at no cost. Letting η_i be the number of members of the set $\{x_i^t \mid x_i^t \neq \phi\}_{t=1}^T$ and $n(x_i^t)$ the number of submitted bids that match x_i^t , the payoffs of the players take the following form:

$$u_i = \begin{cases} K - \eta_i c - \hat{x}_i^t & \text{if } \hat{x}_i^t = \min \{x_k^t \mid n(\hat{x}_k^t) = 0 \text{ for } k \in \{A, B\}\} \\ -\eta_i c & \text{otherwise} \end{cases} \quad \text{for } i \in \{A, B\}$$

$$u_s = (\eta_A + \eta_B) c + \hat{x}_i^t - K$$

⁶If at the end of the auction a unique offer does not exist, then the good is sold to the bidder that submitted first the lowest offer. This same tie breaking rule is the one used in reality.

⁷Notice that a bidder that receives the signal $\sigma(x_i^t) = N$ does not know if x_i^t is higher or lower than the current winning bid.

For what concerns the bidders, three groups of (weakly or strictly) dominated strategies are clearly recognizable: 1) submit bids that are higher than the net value of the object (i.e., $x_i^t > K - c$); 2) submit so many bids such that costs overcome possible profits (i.e., $\eta_i > \frac{K - \hat{x}_i^t}{c}$); 3) bid more than once the same number (i.e., $x_i^t = x_i^{t'}$). Nevertheless the game is far from being dominance solvable. The following proposition defines the equilibrium of the game.

Proposition 1 *The unique subgame perfect Nash equilibrium of the game is such that no auction takes place.*

Proof. We solve the game by backwards induction. If the seller S opens the auction the pure strategy Nash equilibria of the induced subgame are such that, for any $i, j \in \{A, B\}$:

- $\hat{s}_i = \left\{ \left\{ x_i^t = t \right\}_{t=1}^{\hat{t}} \cup \left\{ x_i^t = \phi \right\}_{t=\hat{t}+1}^T \right\}$ where \hat{t} is such that $K - \hat{t}c - 1 > 0 > K - (\hat{t} + 1)c - 1$.
- $\hat{s}_j = \left\{ \phi \right\}_{t=1}^T$ if $s_i = \hat{s}_i$; otherwise $\hat{s}_j = \left\{ \left\{ x_j^t = t \right\}_{t=1}^{\tilde{t}_{\min}} \cup \left\{ \phi \right\}_{t=\tilde{t}_{\min}+1}^T \right\}$ where $\tilde{t}_{\min} = \min \{ \tilde{t} \}$ and $\{ \tilde{t} \} \subseteq \{ 1, \dots, \hat{t} \}$ such that $\{ \tilde{t} \} \cap \left\{ x_i^t = t \right\}_{t=1}^{\hat{t}} = \phi$.

Both equilibria lead to $u_i = K - \hat{t}c - 1$, $u_j = 0$. Being equilibria, notice that there are no profitable deviations: if i plays \hat{s}_i , j can win the auction only by deviating to $s_j = \left\{ \left\{ x_j^t = t \right\}_{t=1}^{\hat{t}+1} \cup \left\{ \phi \right\}_{t=\hat{t}+2}^T \right\}$ but this would imply $u_j = K - (\hat{t} + 1)c - (\hat{t} + 1) < 0$. On the other hand, bidder i cannot avoid to place some bids $\{ \tilde{t} \} \subseteq \{ 1, \dots, \hat{t} \}$ as this would give j the possibility to step in, win the auction with positive profits and turn i 's payoff to $u_i = -\eta_i c$. In addition to the two pure equilibria, there is also a symmetric mixed equilibrium in which each bidder plays $\hat{s}_j = \left\{ \phi \right\}_{t=1}^T$ with probability $p = \frac{2\hat{t}c - K + 1}{K - 1}$ and $\hat{s}_i = \left\{ \left\{ x_i^t = t \right\}_{t=1}^{\hat{t}} \cup \left\{ x_i^t = \phi \right\}_{t=\hat{t}+1}^T \right\}$ with probability $(1 - p) = \frac{2(K - \hat{t}c - 1)}{K - 1}$. In this case, the expected payoff is $u_i = 0$ for both bidders. For what concerns the payoff of the seller, the pure equilibria lead to $u_S = \hat{t}c + 1 - K < 0$ while the mixed equilibrium is such that $u_S = 0$. The auctioneer can only lose by organizing the auction. It follows that the unique SPNE of the game is such that no auction takes place and $u_i = 0$ for any $i \in \{S, A, B\}$. ■

Proposition 1 holds for the case in which $\hat{t} \leq T$, i.e., there are enough periods to potentially implement the subgame equilibrium strategies. Considering that in real lowest unique bid auctions the bidding period usually lasts for some days while the time needed to submit a bid amounts to a few seconds, this condition is certainly met. Notice also that in the mixed equilibrium of the subgame the probability distribution is strongly biased in favour of staying out from the auction. Assuming a standard situation in which the auctioned good worth 200 Euros and the cost associated with each bid is 2 Euros, we would have $k = 20000$, $c = 200$, $\hat{t} = 99$, $p = 0.98$ and $(1-p) = 0.02$. Conditional on the auction taking place, the probability of observing simultaneous entry of the two bidders would thus be extremely small: $(1-p)^2 = 0.0004$. As a final remark, note that the signals the seller sends to the bidders do not play any role in shaping the equilibrium defined by Proposition 1. The situation is radically different when bidders are not fully rational.

3 The game with boundedly rational bidders

According to Proposition 1, no rational auctioneer that expects to face rational bidders should organize a lowest unique bid auction. This equilibrium prediction is clearly at odds with what we observe in reality: not only websites offering lowest unique bid auctions do exist but their number is rapidly increasing. It is thus legitimate to imagine that auctioneers make positive profits. In this section, we show how such an outcome can easily arise thanks to the functioning of quite a perverse mechanism that exploits agents' myopia. We also show how such a mechanism is triggered and amplified by the existence of the signals about the current status of players' bids.

First, let assume that bidders are boundedly rational. In particular, they fail to properly understand the rules of the game or they do not fully work out their implications. On the other side, they are attracted by the appeal of the mechanism and by the possibility of winning a valuable good for very little money. As a consequence, both agents "give it a try" and place an initial bid. Assume player A bids

$x_A^1 = 1$ while player B bids $x_B^1 = 2$.⁸ Following these initial bids, players receive the private signals $\sigma(x_A^1) = Y$ and $\sigma(x_B^1) = M$ and their provisional payoffs at $t = 1$ are given by $u_A^1 = K - c - 1$ and $u_B^1 = -c$. Agent B is thus potentially facing a negative payoff. Still, B can improve his situation by adding the bid $x_B^2 = 1$. This action generates the signals $\sigma'(x_A^1) = N$, $\sigma'(x_B^1) = Y$, $\sigma(x_B^2) = N$ and payoffs $u_A^2 = -c$ and $u_B^2 = K - 2c - 2 > 0$. It is now player A that will incur into losses if nothing changes. On the other hand, A can reach $u_A^4 = K - 3c - 3$ if he submits the bids $x_A^3 = 2$ and $x_A^4 = 3$ such that $\sigma''(x_B^1) = N$, $\sigma(x_A^3) = N$, $\sigma(x_A^4) = Y$. But this implies $u_B^4 = -2c$: B faces even higher losses and has an even stronger incentive to again outbid A . The unique bound to this costly vicious circle is given by T , the closing of the auction. Whenever this limit is not binding, this sort of war of attrition between the bidders can continue even when the costs associated with the number of bids exceed the value of the auctioned good. To see this, imagine that the bidding process has reached the point in which A is leading the auction such that $u_A^{t^*} = K - \eta_A c - \hat{x}_A^{t^*} > 0$ and $u_B^{t^*} = -(\eta_A - 1)c$ but two more bids of B would lead to $u_B^{t^*+2} = K - (\eta_A + 1)c - \hat{x}_B^{t^*+2} < 0$. Agent B is now comparing $u_B^{t^*}$ and $u_B^{t^*+2}$. Both values are negative. Nevertheless $K - (\eta_A + 1)c - \hat{x}_B^{t^*+2} > -(\eta_A - 1)c$ and bidder B prefers to outbid A in order to diminish his own loss. But then in period $t^* + 2$, bidder A will find himself in the situation in which B was at period t^* . Therefore, the same logic applies and the mechanism perpetuates itself.

This feature of lowest unique bid auctions seems to have been directly taken from the Dollar Auction game (Shubik, 1971). The Dollar Auction game is a public English auction where N bidders compete for a good (say one dollar). The prize is won by the agent who submits the highest bid but both him and the second highest bidder must pay their bids. Also in this case, the auction is unprofitable for the seller if agents are rational. But if multiple entry occurs, this starts off a bidding war between the two leading bidders such that the winner may end up paying the dollar more than what it is worth. In both games, the bidding escalation is detrimental for the bidders but is obviously beneficial for the auctioneer. In particular, in the case

⁸An argument that is similar to the one that follows holds for any initial bid x_i^t as well as for a larger number of bidders.

of lowest unique bid auctions, seller's profits are linearly increasing in the number of bids and they are positive whenever $\sum_i \eta_i > \frac{K - \hat{x}_i^t}{c}$. As we will see in the data, this last condition happens to be easily fulfilled in reality.

Going back to the analysis of the bidding mechanism, notice that the assumption of boundedly rational bidders explains initial entry but is not sufficient by itself to trigger the bidding escalation. This task is accomplished by the signals that bidders receive from the auctioneer. To appreciate the fundamental role that signals play, consider how different the situation would be if agents were not receiving any kind of information. In such a case, the incentives to submit additional bids would be much weaker given that each player would hold the legitimate hope to win the auction even with a single bid. And when the auction closes and the ambiguity is resolved, it is then too late for those who did not win to submit other bids. In other words, in terms of ambiguity, the situation would resemble a traditional lottery. On the other hand, signals make the game more similar to a "scratch and win" lottery as they immediately solve the uncertainty about having no chances to win. This encourages overbidding. Indeed, the entire signaling mechanism that characterizes lowest unique bid auctions seems to have been designed with the goal of stimulating emotional responses that are influenced by well known behavioral biases such as irrational escalation of commitment, over confidence and loss aversion. Given the auctioneer's goal (maximize the number of received bids), this obviously comes as no surprise.

4 Empirical analysis

In this section we analyze a dataset that collects information about 100 lowest unique bid auctions that took place in the period February 6th, 2008 - April 6th, 2008. These auctions have been organized by the website bidplaza.it, currently the leader in the Italian market. The rules implemented by this auctioneer are exactly the ones explained in the introduction. In particular the cost associated with each bid is set at 2 euros. For each auction we know the good sold, its market value, the

winning bid and, most importantly, the complete list of submitted bids.⁹ Overall, our dataset collects 100.940 bids. On the other hand, we do not have information about the number of bidders and about how many and which bids each bidder submitted. Nevertheless, the data allow to clearly distinguish some interesting patterns.

First of all, these lowest unique bid auctions succeeded in attracting many people and many bids. On average, each auction received 1.009 bids (min.: 119, max.: 2.917, st. dev.: 635) and, not surprisingly, there is a positive relationship between the market value of the auctioned good and the number of received bids (Pearson's $r = 0,645$). For what concerns the actual number of participants, it is possible to establish a lower bound. In fact, by assuming that no agent submitted more than once the same bid in the same auction, the minimum number of bidders can be inferred by the frequency of the most frequent bid. Therefore, we can say that on average each auction attracted a minimum of 15,3 bidders (min.: 5, max.: 38, st. dev.: 6,45). This value is surely extremely conservative as it would imply that every bidder submitted 66 bids, and thus invested 122 Euros, in every auction. With a more credible guess of 5 bids per individual per auction, the average number of participants increases to 201. In any case, it is pretty obvious that, with respect to the rational prediction, excessive entry occurred. And it is thanks to the high level of participation that the auctioneer has been able to make positive profits on every single auction. A cautious estimate shows that profits per auction total on average to the 441% of the market value of the good (min.: 19%, max.: 1.082%, st. dev.: 237%). In absolute terms, profits amount to 123.920 Euros in front of 27.490 Euros of total costs.¹⁰

⁹This is the list of goods to which our data refer. The notation $k(v, n)$ indicates that good k whose market value is v has been offered in n different auctions (therefore $\sum_k n = 100$): Sony Playstation 3 (400, 10), Sony Playstation Portable Slim & Lite (190, 10), Digital Camera IXUS 860IS (350, 9), iPod Touch 16 GB (400, 8), iPod Nano 8 GB (200, 9), iPod Shuffle 1 GB (80, 7), Bose Companion 3 multimedia speaker system (295, 10), Samsung CE 1070TS microwawe oven (240, 9), Nintendo Wii (250, 10), Philips Digital PhotoFrame Wood 10FF2CWO (250, 4), TomTom One V3 Portable GPS Navigation System (200, 9), XBOX 360 Elite (450, 5).

¹⁰Despite knowing the market value of the goods, the number of bids received and the unitary cost of 2 Euros per bid, profits cannot be computed with certainty. In fact, this website offers a welcome bonus such that a user's first deposit of money is doubled. Therefore, some of the bids are virtually for free. We adopt the conservative approach of assuming that only 75% of the bids generated actual revenues for the seller. On the other hand, it is likely that the seller paid the goods less than their market value due to quantity discounts or marketing reasons.

Some features of bidders' behavior also noticeably stand out. Focusing on the 97.225 bids that picked numbers belonging to the set $\{1, \dots, 500\}$ (96,3% of total bids, the remaining ones are mainly outliers), what emerges is that the majority of them consist of odd numbers. In particular, 54.230 bids (55,8%) are odd numbers while only 42.995 (44,2%) are even numbers. A normally approximated binomial test shows that this difference is significant at the 1% level. Moreover, at the aggregate level, 9 out of the 10 most frequent bids are odd.¹¹ The preference for odd numbers can be easily explained. In a lowest unique bid auction, players want to submit bids that no one else chooses. Therefore, they tend to submit bids that they perceive to be original: odd numbers (a part from those whose trailing digit is 5) and, even better, prime numbers. But the aggregate result of this individual strategy is quite paradoxical as agents end up converging on non-focal numbers. A similar behavior emerges also in the paper by Östling *et al.* (2007) and is analogous to the one first described in Crawford and Iriberry (2007) for what concerns Hide and Seek games. In the context of lowest unique bid auction, such a bidding behavior confirms the hypothesis of boundedly rational bidders. In particular, agents erroneously think to be smarter than the opponents and only perform a limited number of steps of reasoning. Indeed, the data show that submitting an odd bid is suboptimal as the large majority of winning bids are even numbers (68 vs. 32, with the difference being significant at 1% level). Notice moreover that our data do not allow to control for the level of experience of the players. The bias in submitting odd bids would probably be even more pronounced if only agents that play the game for the first few times were considered.

In addition to the general indication that even bids are more likely to win, we now investigate if there are some specific variables that may systematically influence the actual values of the winning bids. In particular, we consider the following variables:

- A) - the value of the good (VALUE)
- B) - the winning bid in the previous auction (WB last)

¹¹The complete top ten list, with aggregate frequency in brackets, is the following: 1 (1287), 11 (1039), 17 (936), 3 (841), 13 (822), 111 (813), 23 (798), 7 (777), 2 (766), 27 (741). As a matter of comparison, "trivial" numbers like 10, 20 and 100 attracted respectively 506, 498 and 471 bids.

C) - the ratio between the winning bid and the value of the good in the previous auction (RATIO)

D) - the average winning bid in the previous 5 auctions (AV. WB last 5)

E) - the winning bid in the last auction with an analogous good (WB last =)

Not all these data are equally accessible to bidders. The webpage where users submit their bids clearly displays the value of the good on sale as well as the list of the last 5 auctioned goods with their relative winning bids. Therefore, a bidder can immediately know variables A) and B) while he can compute variables C) and D). For what concerns variable E), the bidder must click to a different page and browse through the list of closed auctions (on average the same good is auctioned every 14 auctions, i.e., 5-6 days). We do not consider the number of received bids as a possible regressor because this information is not available to bidders during the bidding period.

Table 1 reports the results of OLS regressions. Columns 1 to 5 show the coefficients of the five regressors when these are considered individually. Only the market value of the good on sale is characterized by a significant (positive) coefficient. Column 6 refers to a regression that includes all the covariates. The value of the auctioned good confirms to be the only significant regressor. In any case, all the specifications have little explanatory power.

	1	2	3	4	5	6
Intercept	8.080 (18.214)	86.193* (7.6038)	82.266* (12.074)	95.107* (16.300)	79.377* (10.812)	0.309 (24.158)
VALUE	0.0029* (0.0006)					0.0034* (0.0007)
WB last		0.009 (0.009)				0.012 (0.008)
RATIO			1873.853 (2956.352)			2888.816 (2713.244)
AV. WB last 5				-0.038 (0.087)		-0.041 (0.080)
WB last =					0.105 (0.097)	-0.118 (0.100)
R-squared	0.183	0.011	0.004	0.002	0.012	0.220
Observations	100	100	100	100	100	100

Table 1: OLS regressions. Standard errors in parentheses. * Significant at 5% level.

To sum up the content of this section, the data about actual auctions convey

three main results:

- Contrary to equilibrium prediction, lowest unique bid auctions are (highly) profitable for the sellers.
- Bidders display bounded rationality both in the entry decision and in their bidding strategies.
- Winning bids follow quite a random pattern.

5 Discussion

The paper introduced and analyzed a peculiar selling mechanism that is getting increasingly popular over the internet: lowest unique bid auctions that allocate valuable goods to the agent who submits the lowest bid that is not matched by any other bid. We showed that auctions of this kind are unprofitable for the seller if bidders are fully rational. But we also showed why in reality this auction format is so successful: myopic bidders are tempted to place an initial bid but once they do that they are locked in a costly war of attrition that highly rewards the auctioneer. In particular, we highlighted how such a mechanism is driven by the existence of the signals about the current status of a player's bid. It is therefore ironic to notice how websites that organize lowest unique bid auctions overstress, surely a bit in bad faith, the alleged positive role of the signals.¹² While it is clear why they do so (they have to justify the fixed cost associated with each bid and they want to distinguish themselves with respect to pure lotteries and gambling), the paper clearly showed that, for what concerns the bidders, signals are at best a double edged weapon.

Lowest unique bid auctions suffer also from other potential problems that should suggest prudence. For instance, they share the technological hitches that characterize on-line auctions: problems of connectivity, delays or congestion, possibly due to last minute bidding or "sniping" (see for instance Roth and Ockenfels, 2002). Col-

¹²For instance, one of these websites claims that "Relying on these signals, using different strategies and different levels of investment, to win the auction becomes a matter of a complex use of various abilities". Another website declares: "The investment, the signals and the bidding strategies make the auction void of any element of luck and based exclusively on the bidder's ability".

lusive behaviors are also an important issue. While collusion among bidders seems unlikely due to the secrecy of agents' identities and to problems of coordination, collusion between the auctioneer and a single bidder looks much more easily implementable. Bids are private information but the auctioneer get to know them in real time. In theory, he could then indicate to a third party where to place a winning bid seconds before the auction closes. Obviously this would turn the auction into a scam. We do not think that lowest unique bid auctions are scams: the mechanism is too profitable for risking to ruin it with such a trick. And indeed, to speak the truth, these websites put quite some effort in trying to build and maintain a reputation for being a trustable and transparent outlet.

To sum up, lowest unique bid auctions are a very smart selling mechanism. On one hand, by giving the possibility to win goods of considerable value for very little money, they share the appeal of lotteries. On the other hand, they give bidders the illusion to be in control of what they do and they convey the idea that winning is just a matter of being smarter than the others. The combination of these two factors makes the business successful and this in turn explains continuous entry in the industry. Entry will surely stimulate competition and lead to better conditions for the players: lower participation fees, higher initial bonuses, lower number of opponents. Nevertheless, the basic mechanism underlying the auction format will remain the same such that the analysis of this paper will continue to be valid. We conclude by stressing once again the similarities that lowest unique bid auctions have with other well known games like the war of attrition and the Dollar Auction Game. It is obviously not a coincidence that these games are used as archetypes to describe situations where irrational behavior leads to an inefficient waste of resources.

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