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FACULTY OF ECONOMICS AND MANAGEMENT

Information Revelation in an Online Auction with Common Values

Sascha Füllbrunn

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Otto-von-Guericke-University Magdeburg
Faculty of Economics and Management
P.O. Box 4120
39016 Magdeburg, Germany
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Sascha Füllbrunn

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Abstract:
The Hard Close auction has become a familiar auction format in online markets and in a private value framework this dynamic second-price auction format has experimentally been tested in recent studies. Considering a common value framework, Bajari and Hortaçsu (2003) demonstrate that in the Hard Close auction format bidders, using a sniping strategy, do not provide information during the auction. We provide contrary results from a laboratory experiment. Bidders provide information during the bidding process, resulting in different bid functions that depend on the bidders' private information rank. However, the market results are in line with the theory.

Keywords: auctions, electronic markets, experiments
JEL No: C73, C9, D44

Otto-von-Guericke-Universität Magdeburg
Faculty of Economics and Management
E-Business
Postbox 4120, 39016 Magdeburg
eMail: Sascha.Fuellbrunn@ovgu.de Phone: +49 391 67 – 11688

1. Introduction

The Hard Close auction has become a familiar auction format in online markets, with the most popular auction site, eBay, using this format to sell almost anything one can imagine. Bidders have a pre-specified time period to submit bids. Afterwards, due to the proxy bidding system, the bidder with the highest bid receives the object and pays a price that equals the second highest bid.[1] Particular attention in this auction format is paid to the deadline, because in the last point in time bidders can submit one final bid, leaving no possibility for the other bidders to response.[2] Empirical studies show that bidding activity is concentrated at the end of the auction (Ockenfels and Roth 2002, Bajari and Hortaçsu 2003, Anwar et al. 2006, Hayne et al. 2003, Wilcox 2000) and many strategic reasons for late bidding have been found (Ockenfels and Roth 2006, Wintr 2004, Engelberg and Williams 2005, Rasmusen 2003, Hossain 2006, Füllbrunn 2007).[3]

We introduce common values to Hard Close auctions and provide evidence from a laboratory experiment.[4] Theoretical and empirical literature support late bidding behavior in Hard Close auctions with common values. Assuming symmetric bidders, Bajari and Hortaçsu (2003) develop a model where information revelation during the Hard Close auction cannot be an equilibrium. They predict that bids

[1] In the proxy bidding system bidder *i* submits a maximum bid she is prepared to pay and a bidding agent overbids all other bidders as long as *i*'s maximum bid is reached. Therefore, the current bids equals (is an pre-specified bid increment higher) the second highest maximum bid.

[2] We do not examine transmission problems in the very last point in time. For a discussion and experimental results on that issue, see Ariely et al. (2006).

[3] Further mentioned reasons for late bidding or therefore, for multiple bidding are auction fever (Heyman et al. 2004), escalation of commitment and competitive arousal (Ku et al. 2005), the pseudo-endowment effect (Wolf et al. 2005).

[4] Hard Close auction experiments with private values have been recently conducted by Sherstyuk (2007), Ariely et al. (2006), and Füllbrunn and Sadrieh (2006).

arrive only in the last stage. Assuming asymmetric bidders, Ockenfels and Roth (2006) provide a model where experts submit bids late in the auction in order to avoid revelation of more accurate information to the dealer. In an empirical study, Roth and Ockenfels (2002) show a higher frequency of late bidding in eBay auctions with *Antiques*, where “retail prices are usually not available and the value of an item is often ambiguous and sometimes require experts to appraise”, than with C*omputers*, where “information about the retail price of most items is in general easily available”.

In contrast to these theoretical results we find clear evidence for information revelation in Hard Close auctions. During the entire auction process bids are correlated to the private signals. Therefore, final bids not only depend on the signal value, but also on the ranking position of the signal, i.e. bidders with high signals submit lower bids relative to their signal than bidders with low signals. However, the market results are in line with theory.

In the next section, we describe the game and the equilibria. We discuss the experimental design in section 3, and report results in section 4. We conclude our findings in section 5.

2. The Game

We examine a multi-stage dynamic second-price auction with an affiliated common value model. The value of the object V is drawn from a uniform distribution on the interval $[V_l; V_h]$. During the auction the bidders do not know the common value, but each bidder i ($i = 1, \dots, n$) receives a private signal s_i that is an unbiased estimation of the object valuation. Bidders are symmetric in that the distribution of the signals is identical for all bidders. We assume risk neutrality. The signals are identically and independently drawn from a uniform distribution that is centered on V with upper limit $V + \varepsilon$ and lower limit $V - \varepsilon$. We concentrate our analysis only on signals within the "region 2" interval (Kagel and Levin 2002), i.e. $V_l + \varepsilon \leq s \leq V_h - \varepsilon$, because bidders with signals out of region 2 have additional information associated with the end-point values V_l or V_h, respectively.[5] Assume $s_n > s_{n-1} > \cdots > s_1$.

The Hard Close auction is modeled as in Füllbrunn and Sadrieh (2006), i.e. as a dynamic second price auction. Each auction has a fixed amount T of bidding stages. In each bidding stage t, every bidder has the opportunity to submit her first bid or to raise her previous bid. In the last stage the bidders may submit a final bid. At any time t the current price p_t is equal to the second highest bid submitted in the previous stage. The current holder(s) at time t is (are) the bidder(s) who has (have) submitted the highest bid. In each stage all bidders are informed on the current price and on their status as current holders. They are not informed on the bids of the other bidders. When the auction ends, the current holder receives the item and pays the current price. Ties are broken by assigning the item with equal probabilities to one of the current holders. The payoff of the buyer - the bidder who receives the item – equals the difference between the common value and the second highest bid.

Our game theoretic analysis follows Bajari and Hortaçsu (2003) who model a Hard Close auction as an open-exit ascending auction in a first stage and a Vickrey

[5] A consideration of signals in the whole valuation interval makes the analysis and the interpretation unnecessarily complicated for our purposes.

auction in a second stage. Consider a Hard Close auction with $n > 2$ and $T = 2$ where in the second stage (sub game) all bids apart from the highest are revealed. Note, that without further information the sub game equals a Vickrey auction with the equilibrium bid $b^V(s) = s - (n-2)\varepsilon/n$ (e.g. Harstad 1990, p. 424). In the first stage, bidders submit either an informative bid $b^I(s)$ or a non-informative bid b^U. An informative bid allows an inference on the signal, i.e. $(b^I)^{-1}\left(b^I(s)\right) = s$. We assume that $b^I(s)$ is well defined, i.e. each bidder can submit an informative bid. Further on, $b^I(s) \leq b^V(s)$ and $b^I(s) > 0$. The bid function is common knowledge. A non-informative bid does not reveal any information on the bidders signal. To simplify matters, we assume $b^U = 0$. We refer to a symmetric equilibrium in pure strategies where all bidders use the same bid function in the first stage.

Informative first stage bids

Assume all bidders submit informative bids in the first stage, i.e. $b_{1,i}(s_i) = b^I(s_i)$. In the sub game all signals apart from the highest are revealed. Especially, the current price p equals the informative bid of the bidder with the second highest signal. Therefore, the sub game bids equal the conditional expectation of the valuation given the known signals. This is

$$b_{2,n} = max\left\{b_{1,n}, E\left[V | s_1 = (b^I)^{-1}\left(b_{1,1}\right), \ldots, s_{n-1} = (b^I)^{-1}\left(b_{1,n-1}\right), s_n\right]\right\}$$

for the bidder with the highest signal, and

$$b_{2,k} = max\left\{p, E\left[V | s_1 = (b^I)^{-1}\left(b_{1,1}\right), \ldots, s_{n-1} = (b^I)^{-1}\left(b_{1,n-1}\right), s_n > (b^I)^{-1}\left(b_{1,n-1}\right)\right]\right\}$$

for all other bidders k ($k = 1, \ldots, n-1$). The according symmetric strategy is

$$B^I(s_i) = \left\{ b_1 = b^I(s_i); b_2 = \begin{cases} b_{2,n} & \text{, if } b_{1,j} = b^I(s_j) \; and \; i = n \\ b_{2,k} & \text{, if } b_{1,j} = b^I(s_j) \; and \; i = k \\ b^{BR} & \text{, otherwise} \end{cases} \right\}.$$

The best response on constellations of deviating bidders, i.e. bidders who submit non-informative bids in the first stage, is represented by the sub game bid b^{BR}.

Non-informative first stage bids

Assume all bidders submit non-informative bids in the first stage, i.e. $b_{1,i} = b^U$. In the sub game neither signal is revealed. Hence, the bidders sub game bid equals b^V. The according strategy is

$$B^U(s_i) = \left\{ b_1 = b^U; b_2 = \begin{cases} b^V & \text{, if } b_{1,j} = b^U \\ b^{BR} & \text{, otherwise} \end{cases} \right\}.$$

The best response on constellations of deviating bidders, i.e. bidders who submit informative bids in the first stage, is represented by the sub game bid b^{BR}.

$B^I(s_i)$ cannot be a equilibrium strategy in a symmetric Nash equilibrium. According to lemma 2 in Bajari and Hortaçsu (2003) the first stage bid cannot be a monotonic function in the bidders signal. This is due to the fact that a unilateral deviation decreases the conditional expectations of the other bidders, and hence, increases the probability of receiving the object.

$B^U(s_i)$ is a equilibrium strategy in a symmetric Nash equilibrium. If all other bidders j follow the strategy $B^U(s_j)$ a strategy $B^U(s_i)$ of bidder i is a best response. However, a unilateral deviation in the first stage has no disadvantages as long as all other bidders bid according to B^U. Hence, in the symmetric Nash equilibrium the

Hard Close auction is equivalent to a Vickrey auction.[6] (See also Bajari and Hortaçsu 2003, p. 338).

Due to the fact that the equilibrium strategy in a Hard Close auction holds in the stages $T-1$ and T, the equilibrium strategy for $T \geq 2$ equals

$$B^*(s_i) = \left\{ b_{t<T} = b^U; b_T = \begin{cases} b^V & \text{, if } b_{1,j} = b^U \\ b^{BR} & \text{, otherwise} \end{cases} \right\}.$$

We expect "non-serious bids", i.e. low or zero bids that are not correlated to the signal and, thus, conceal information in the first T-1 stages. Finally, in stage T we expect to observe Vickrey bids (b^V).

However, in this equilibrium consideration the bidders are fully rational. We do not differentiate between boundedly rational bidder types.

3. Experimental Setup

The experiment was programmed and conducted with the software z-Tree (Fischbacher, 2007) and took place in the Magdeburger Experimental Labor (Maxlab) with undergraduate students from the University of Magdeburg.[7] Almost all subjects were students of the faculty of economics and management and had not participated in an auction experiment before. After the instructions were read aloud,[8] the students were randomly assigned to the terminals.

[6] See the corresponding results in Bajari and Hortaçsu (2003) in proposition 1.

[7] For recruitment we use the ORSEE recruitment software from Greiner (2004).

[8] Instructions are in the appendix and subjects were truthfully instructed about all the features of the experimental design.

Bids and values were expressed in an experimental currency unit (ECU) which at the end of a session was transferred from 1 ECU into 0.0056 Euro Cents. The participants received an endowment of 1800 ECU (≈ 10 Euro) to absorb losses.[9] At any time, all subjects had knowledge about their ECU balance that was calculated by adding the payoff of each auction to the endowment. At the end of a session, the bidders ECU has been paid-out in Euros. On average the experiments lasted 1.5 hours and bidders received 13.25 Euro.

Subjects were randomly and anonymously matched before each auction. The random draws were organized in such a way that 8 out of 16 subjects in each session represented an independent observation group. Since 64 subjects took part in 4 sessions, we collected data from 8 independent observation groups. A total of 16 auctions were played by each subject. To get familiar with the common value environment the first 4 auctions were trial periods without monetary incentives.

Before an auction started, the sealed common value was drawn from the interval [2,500; 22,500]. Afterwards the signals were drawn from the interval $[V - 1{,}800; V + 1{,}800]$.[10] With $n = 4$ and $\varepsilon = 1{,}800$ the Vickrey bid equals $b^V = s - 900$.[11] Each Hard Close auction was played with six stages. After the auction the bidders observe the valuation of the object and the price.

[9] Especially in common value auctions inexperienced bidders fall prey to the winner's curse and receive negative profits.

[10] We "borrow" the parameter setting from Cox et al. (2001).

[11] We set $n > 3$ because we want to avoid non-negative expected profits for naïve bidders. Naïve bidders do not consider information apart from their signal and bid $b(s) = E[V|s] = s$.

4. Experimental Results

ORGANIZATION OF DATA

In total 256 auctions with 1024 observations were conducted. However, not all observations can be used to provide accurate results. We only consider signals from the "region 2" interval (compare p. 3), i.e. we discard auctions with signals lower than 4,300 ECU and higher than 20,700 ECU. The endowment proved to be too low for some bidders who ended the experiment with a negative balance. The enforcement of payment transactions from subjects was not credible and, thus, we discard all auctions with bidders that *ever* had a negative credit balance.[12] This leaves us with 154 auctions, i.e. 616 observations overall.

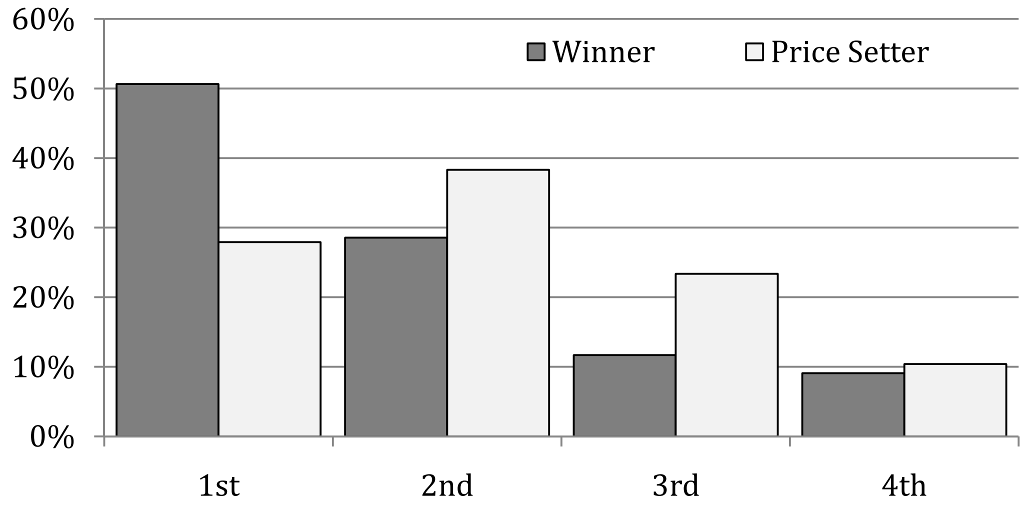
ALLOCATION AND PRICE DETERMINATION

Figure 1 shows the distribution of winners and price setters across signal ranks. The equilibrium predicts the winner to have the highest signal. In merely half of the auctions the bidder with the highest signal wins. The Vickrey auction experiments of Kagel, Levin and Harstad (1995) report a higher percentage. However, with more than four bidders the results are in line with ours. A second piece of evidence that subjects do not behave as theory predict is that the price is not determined by the bidder with the second highest signal in the majority of the cases. **Hence, the winner is not necessarily the bidder with the highest signal. The price setter is not necessarily the bidder with the second highest signal.** However, the modal bidder in both cases behaves as the theory predicts.

[12] It is possible to enforce payments from subjects. But we do not want to deter subjects from later experiments. With a negative balance the bidding strategy changes: bidders may submit the highest bid in order to increase the probability to receive positive profits without being afraid of financial consequences.

The difference between signals might have a significant impact on these frequencies. Actually, a low difference between the highest and the 2nd highest signal leads to a lower frequency of bidders with the highest signal that wins the auction (40%) while a high difference leads to a frequency of 70%.[13] However, the difference between the 2nd and the 1st or the 2nd and the 3rd highest signal does not have an impact on the result concerning price determination.

Figure 1: Frequency of winners and price setters by signal ranks



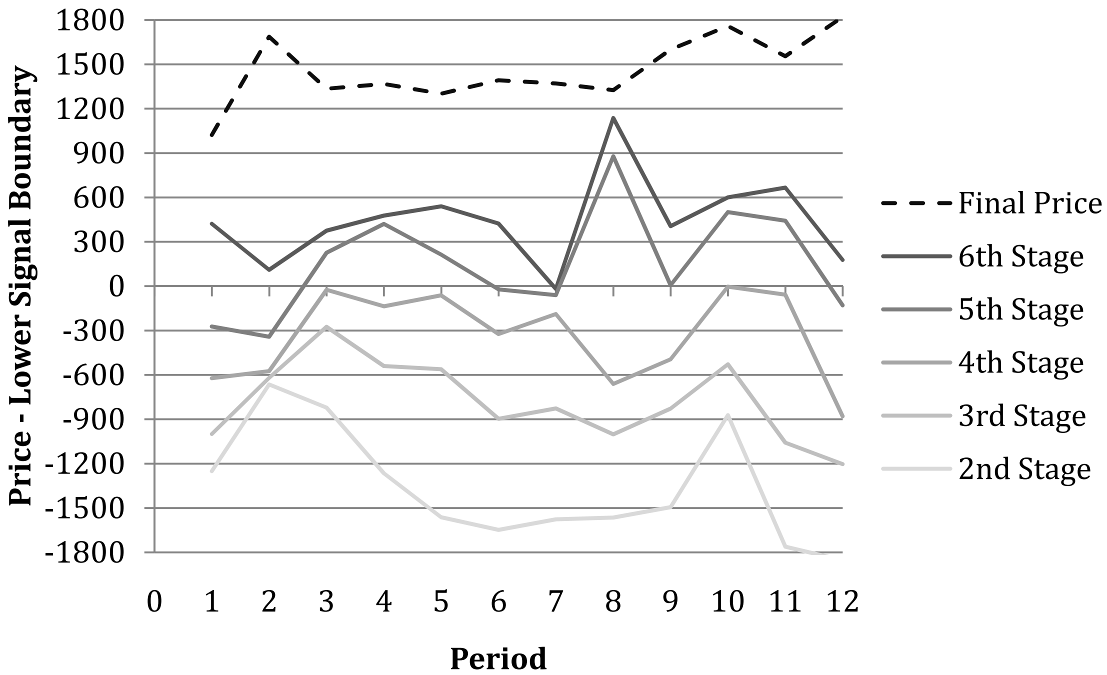
CURRENT PRICES

The prices in any stage equal the 2nd highest bid from the previous stage. Figure 2 displays the standardized median current prices in each stage over time, i.e. the observed price minus the lower signal range boundary.[14] For 0 the standardized price equals the lower boundary and for 1,800 it equals the common value. Comparing the observations of the 1st and the 2nd half show no significant

[13] Fourfold test categories: low difference (difference < 720) , high difference (>720) and highest and second highest signal. A significance level of 1% rejects the hypothesis that there is no correlation between difference and signal rank winner (test statistic 10,67 > 6,64).

[14] Due to the randomized common value the signal range (i.e. the interval $[V - 1{,}800;\ V + 1{,}800]$) in each auction is different. To enable a comparability of prices we standardized prices in the lower signal range boundary, i.e. the standardized price in stage *t* equals $p_t - (V - 1{,}800)$.

Figure 2: Observed Median Prices



differences in price over time for any stage of the auction. In the 3rd stage prices are significantly below the signal range boundary (Wilcoxon test, two tailed: p = 0.0357) and increases from stage to stage, exceeding the boundary in the 4th stage. In about 60% of the auctions the last observed price exceeds the boundary. However, although the standardized median current price in the last stage equals 406 ECU the deviation from the boundary is not significant. **Hence, the current price in the last stage provides information on the lower signal range boundary.**

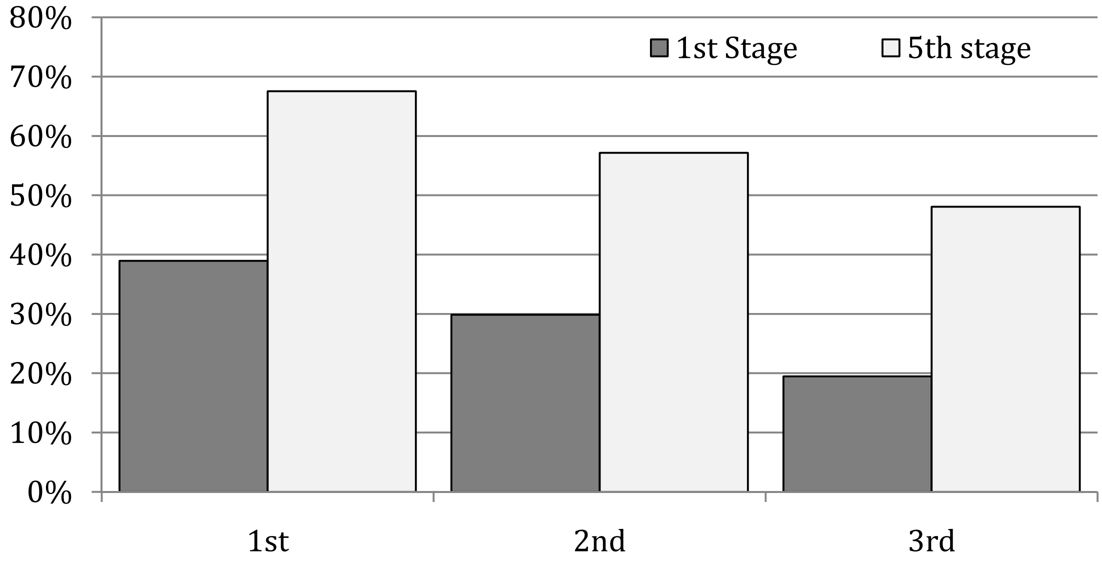
Furthermore the current price represents the bidding boundary. Especially a bid in the last stage has to exceed the current price. Therefore, if prices are sufficiently high, some bidders are not able to submit a Vickrey bid. In this case, the last observed price provides information at least for bidders with low signals. We observe a large number of bidders who cannot submit their equilibrium bids in the end, i.e. 65% of bidders with the 4th, 50% of bidders with the 3rd, 23% of bidders with the 2nd, and even 11% of bidders with the 1st highest signal. Comparing the observations of the 1st and the 2nd half show no significant differences over time. Actually, 19% of bidders with the 3rd and 36% of bidders with the 4th highest signals are not able to submit bids that equal their signal. **Hence, the last observed price hinders a substantial number of bidders to submit their equilibrium bids in the last stage.**

INFORMATIVE BIDS

In this analysis we call a bid b^I *informative bid* if it improves the information of other bids. The informative bid does not exceed the Vickrey bid due to the fact that without information the bidders submit Vickrey bids in the last stage. Let $(b^V)^{-1}\left(b^I(s_j)\right) = \hat{s}_j$. $\hat{s}_j$ is a lower boundary of the signal s_j and gives information on the value due to $V \geq \hat{s}_j - \epsilon$. Hence, for bidder i with the consideration $V \in [s_i - \epsilon, s_i + \epsilon]$ an information $\hat{s}_j$ is informative if $\hat{s}_j > s_i$. In this case, the interval in which the common value could be shrinks to $V \in [\hat{s}_j - \epsilon, s_i + \epsilon]$, leaving bidder i with more information.

Using the equilibrium strategy, no informative bids should be observed until the last stage. Figure 3 displays the frequency of *ex post* informative bids, i.e. bids that exceeds the lowest realized signal. Already in the 1st stage the bidders in all ranks submit informative bids. They increase from 30% in the 1st stage to about 58% in the 5th stage. Considering the *ex ante* informative bid, i.e. bids above $s - 4{,}500$, the frequency reaches 75% in the 5th stage.[15]

Figure 3: Frequency of ex post informative bids



Comparing the observations of the 1st and the 2nd half show no significant differences of the discussed frequencies over time. **Hence, the high frequency of informative bids provides further support for an information revelation hypothesis.**

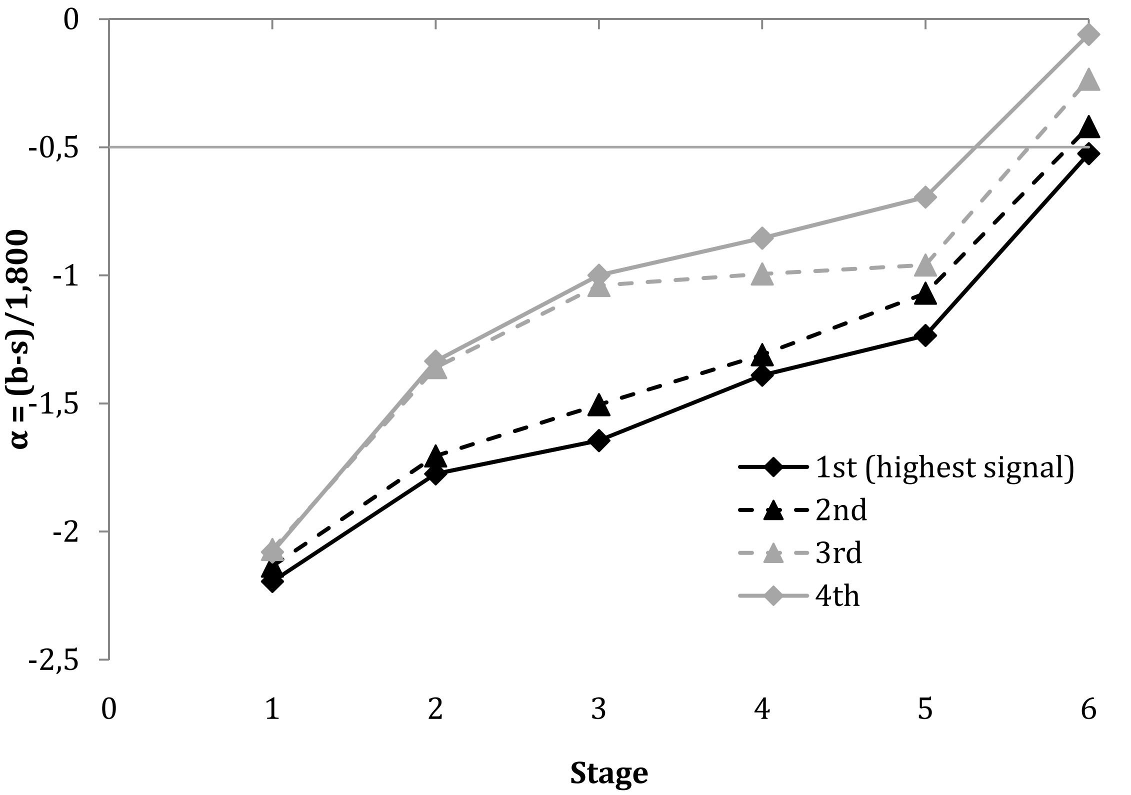
BIDFUNCTION

Without further information the bidders submit bids according to a monotonic function of their signal. In order to test whether the bidders use the same bid function we define a bid shading parameter α that classifies the bid function due to $b(s) = s + 1{,}800\alpha$.. For α= -0.5 the bidders submit equilibrium bids, for $\alpha < -0.5$ bids undercut the equilibrium and for $\alpha > 0$ bids exceed the signal.

[15] In the extreme case, the signal s_j equals $V + 1{,}800$ and the signal s_i equals $V - 1{,}800$ with a difference of 3,600. For $\hat{s}_j \leq s_i$ the bid is non-informative, i.e. $b^V(\hat{s}_j) < s_i - 900$. Hence, a non-informative bid undercuts $s - 4{,}500$.

Comparing the observations of the 1st and the 2nd half show no significant differences in α separated by the signal rank. Figure 4 displays the median of the bid shading parameter α over stages by signal rank.

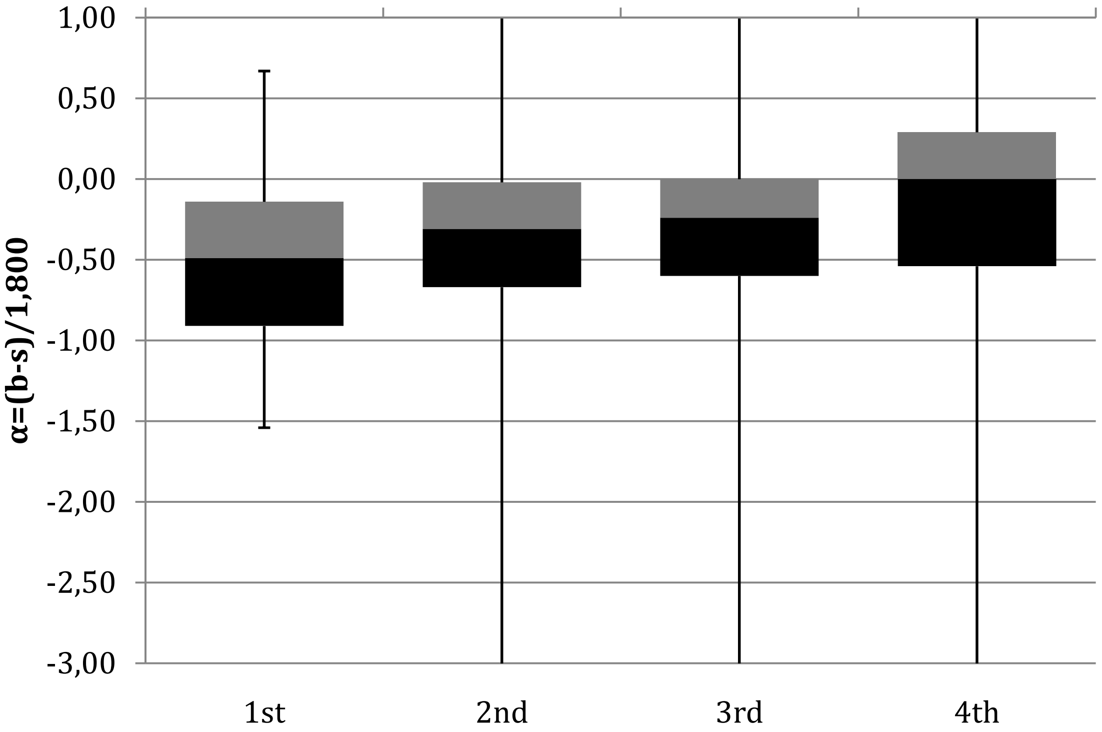
Figure 4: The bid shading parameter α over stages



Some incremental bidding takes place until the 6th stage and then a substantial leap in bidding is observed. The figure shows that the rank of the bidder plays a decisive role. In the first stage α is the same for all bidders. This is due to the fact that the bidders' information only depends on their signal. In the following stages α spreads dependent on the signal rank of the bidders. Most of the bidders submit bids below the equilibrium bids until the 6th stage (α < -0.5). However, in the 6th stage the bids increase with a substantial leap.

Figure 5 shows the box plot of α in the last stage separated by signal ranks (Period 7-12). Actually, α differs across signal ranks. Especially, we observe a difference that can be sorted by signal ranks, i.e. $\alpha_{1st} < \alpha_{2nd} < \alpha_{3rd} < \alpha_{4th}$.[16] The bidders with the 3rd and 4th highest signal submit significantly higher bids than in equilibrium while the other bidders do not submit different bids (Wilcoxon test: two tailed, p = 0.0117).

Figure 5: The bid shading parameter α in the last stage



Only $\alpha_{4th}$is indistinguishable with 0, i.e. the bidders seem to bid their signal. The frequency of bids above the signal (above the Vickrey bid) is 44% (78%) for bidders with the 4th and 26% (67%) for bidders with the 2nd highest value. In contrast, the frequency of bidders with the highest signal is about 13% (45%). Comparing α across the signal rank position leaves significant differences between

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[16] Comparing the distributions of the 1st and the 4th highest signal we found a significant difference (Kolmogorov Smirnov, p = 0.00).

bidders with the highest and the lowest signals (Mann Whitney U test: two tailed, p = 0.0251, Kolmogorov Smirnov test, p = 0.00). Overall, the Friedman test shows that the distributions of the signal ranks are different (p-value 0.0059, Kendall = 0,5203). Hence, the medians of α differ across signal ranks. **Hence, the observed bid functions depend on the signal rank of the bidders signal.**

SNIPING

In order to test whether a sniping strategy is used, we consider final bids. The frequency of final bids in the 6th stage is about 80%. The comparison of the frequency of winning bids in until the 6th stage (18%) to the frequency of winning bids in the 6th stage (82%) shows a significant difference (Wilcoxon test: two tailed, p = 0.0116). **Hence, most of the winners (bidders) submit their winning (final) bid in the last stage, i.e. the bidders snipe.**

WINNER'S CURSE

In equilibrium the winner is the bidder with the highest signal. If she does not take this into consideration her winning bid can result in lower or even negative profits than in equilibrium. *The systematic failure to account for this adverse selection problem is referred to as the "winner's curse"* (Kagel and Levin 1986). The frequency of bidders, who fall prey to the "ex ante winner's curse", reaches 77%. These are the winners who overbid the Vickrey bid and therefore hazard the potential negative consequences.[17] Notice that only half of these bidders have the highest signal. The frequency of bidders, who fall prey to the "ex post winner's curse", reaches 32%. These are the bidders who win the auction and realize a loss. About

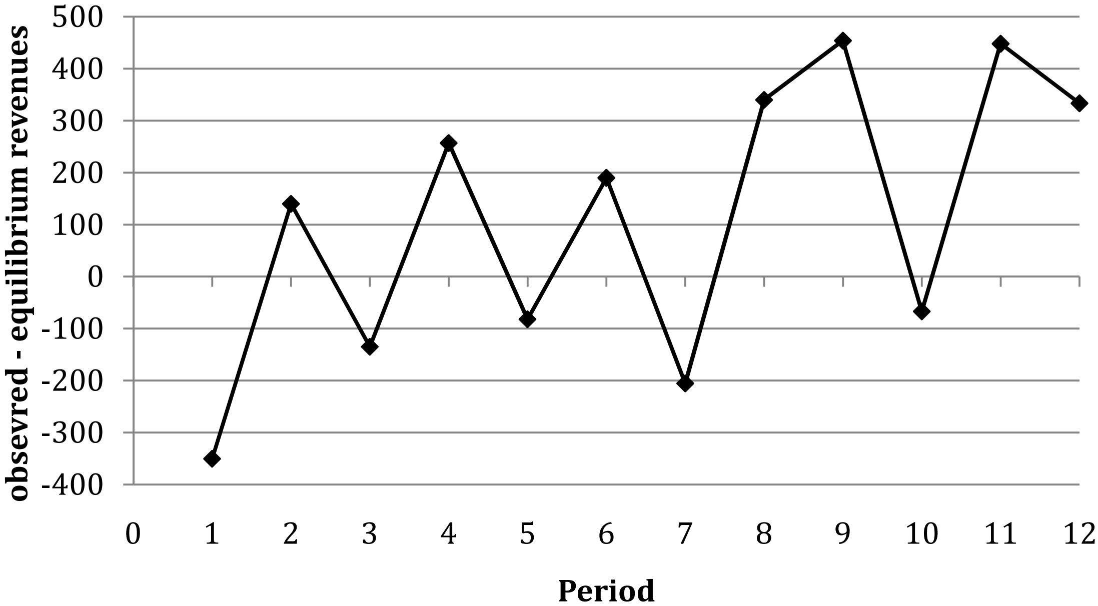
[17] Remember, overestimating the common value in a second-price auction does not necessarily lead to the realization of loss, because the price does not only depend on the won bid.

one-third of these winners have the highest signal. However, 75% of these high signal bidders would have also realized a loss in equilibrium. Comparing the observation of the 1st and the 2nd half show no significant differences in the frequency of bidders who fall prey to the winner's curse in both definitions. **Hence, we observe the winner's curse only to a small extent.**

SURPLUS

Figure 6 shows the development of the median auction surplus. The surplus represents the auction performance compared to the equilibrium (surplus = observed – equilibrium revenues). In equilibrium the surplus equals 0. The development displays no trend in the course of time. Comparing the observation of the 1st and the 2nd half leaves no significant differences in the median surplus. The median surplus slightly exceeds zero but the difference is not significant. **Hence, the observed revenue is not significantly different from the equilibrium revenue.**

Figure 6: Median Auction Surplus



ESTIMATION

To find out whether the bidders realize that information is revealed, we ask the bidders to estimate the common value after the last bid. We did not pay subjects for their estimation task. Hence, the results of this analysis should be considered only to be suggestive.[18]

If no information is revealed the best estimator for the common value is the signal. While the bidders with the highest signal state an estimation significantly below their signal (Median difference: -552, Wilcoxon test: two tailed, p = 0.0117) the bidders with the lowest signal state an estimation above their signal (Median difference: 153). The Friedman test shows a significant difference of the distributions across signal ranks (p = 0.0314), i.e. the higher the signal rank, the lower the estimation in comparison to the signal. This fact reflects the real position of the signal to the common value. Hence, the data suggests that the bidders have an idea of their signal rank. If all bidders have the same information the difference between estimation and common value is the same for all bidders. Assuming all signals are common knowledge the conditional estimation is the average of the signals.[19] The estimation to average difference is not equal across signal ranks. The higher the signal rank, the higher the difference.[20] The Friedman test shows a significant difference of the distributions across signal ranks (p = 0.0314). The median estimate to average difference is 487 for the bidders with the highest, and -875 for bidders with the lowest signal. **Hence, the bidders have**

[18] We discard all estimations beyond $[s-1{,}800, s+1{,}800]$.

[19] This is not necessarily the case. If the highest signal equals the highest and the lowest signal equals the lowest signal boundary, the common value estimation is exact.

[20] The Kendall coefficient equals 0.96.

not the same information, but do also not solely use their signal as information source.

5. Conclusion

For Hard Close auctions the common value model from Bajari and Hortaçsu (2003) predicts equilibrium bidding only in the last possible moment. During the auction the bidders conceal information. We provide results from a laboratory experiment where bidders participate in a Hard Close auction with common values. The observations give reason to believe that during the auction bidders reveal and gather information. Bidders with low signals submit higher bids compared to their signal than bidders with higher signals. Despite clear evidence of information revelation, prices do not differ significantly from the equilibrium prediction. Why do bidders provide information within the Hard Close auction? One possible explanation may be that subjects enjoy competing against each other in bidding wars, just "for the fun of it". Or bidders do not behave rationally. But what intentions do they follow?

Does a parameter variation change the results? Kagel et al. (1995) show, that the market size has a strong impact on bidding behavior. Therefore, with a higher number of bidders we assume more information revelation and higher prices. The common value modeling may be a crucial point. Possibly, a model as in Krishna and Morgan (1997) changes the results. They use a common value model in which the value equals the average of the signals. In that case, we expect even more information revelation because the signals and the value correlate more strongly. If we model the auction, for example, as in Ariely et al. (2006), where the bidders submit bids in an English auction format in the first stage and then have the possibility to submit one last bid in a second stage, we expect a higher level of information revelation since the bidders have more flexibility to react on each others' bids. Furthermore, it will be interesting to see if Hard Close auctions reveal information, where dealers and one expert together bid in a common value environment as in Ockenfels and Roth (2006). However, we expect less information revelation in their setting, because the advantage due to an information revelation is higher for the dealers than for the expert.

Although bidders provide a substantial amount of information in our simple Hard Close auctions, the seller would prefer that even more information is revealed. This is true, because the bidders would bid more aggressively, increasing the revenue of the seller above the levels we observe. In Füllbrunn and Sadrieh (2006) we test an alternative auction design in a private value environment, the *Candle Auction*, where bidders do not know whether a bidding stage is the last one or a further stage will come up. In Candle Auctions we predict higher prices and an even stronger information revelation process for a common value environment.

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Appendix

Instructions (Translation)

Please read the following instructions carefully. Questions will be answered at the terminal. As from now, please stop communication among yourselves. In this experiment you take part in an auction. Therefore, you submit bids in a computer terminal. Your payoff depends on your success, i.e. it depends on your decisions and those of the other participants. For an easy handling you does not submit bids in Euro but in *points*. 180 points correspond to 1 Euro. At the beginning, you get a credit of 1800 points.

The auction

What does the auction looks like? You are a bidder in the auction. In this auction *one* object is offered. The bidder with the *highest* bid receives this object. The price for the object equals the *second highest* bid. In any auction four bidders participate: you and three other participants. However, this *auction group* will be reshuffled after each auction.

What is the bidding procedure? An auction consists of several bidding stages. In each stage, you can submit *one* bid that may not exceed 22,500 points. This bid is not common knowledge. When you want to retain your previous bid, leave the submission field blank. When you want to raise your previous bid, the new bid must exceed the current price. The current price is the second highest bid from the previous stage. After the first stage the current price can be found on the right side of the screen. On the left you will be informed if you are the highest bidder or not.

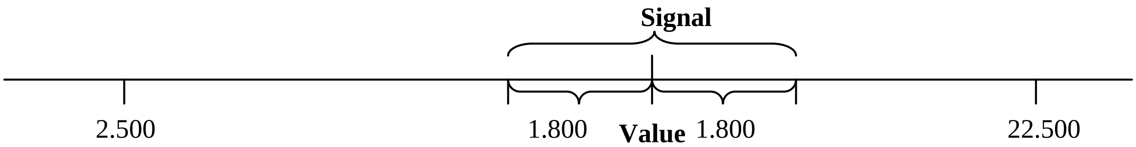
How long does an auction take? After the 6th stage, the auction ends.

Who receives the object? The bidder who finally submits the highest bid receives the object and pays the price. If there are two or more bidders who submit the highest bid, a random mechanism decides on which of the highest bidders receives the object. In this case, the price equals the highest bid.

The payoff

The *value* of the object lie in the range 2,500 and 22,500 points. This value will be randomly assigned to you by the computer, whereby every value in the interval is of same probability. He is from the computer before the auction drawn at random, with each value in the same interval is probable. *No bidder knows this value*.

Each bidder receives a signal, which corresponds to an estimation of the value. This signal is at most 1,800 points below and at most 1,800 points above the drawn value and will be randomly assigned to you by the computer, whereby every value in the interval [value - 1,800, value + 1,800] is of same probability. *This signal is known only to you and not to the other bidders*.



Example: The value equals 18,000 points. The signals will be drawn from the interval with the lower limit 16,200 and the upper limit 19,800. A possible signal constellation in this auction can be 17,384, 17,562, 16,205 and 19,175.

In summary, one object is sold via an auction. Its value is not known and equal for every bidder. You receive a signal, which is an estimate of that value. Each of your group member also receives a signal. All bidders only know their own signal, and not the valuation of the object nor the signal of other bidders. If you receive a relatively high signal, the value is relatively high, and the other bidders have also relatively high signals. If you receive a relatively low signal, the value of the object is relatively low, and the other bidders have also relatively low signals.

How is the payoff calculated? If a bidder receives the object, its payoff equals **value – price**, i.e. you receive the valuation in points and pay the price. This difference will be added to the credit of the highest bidder. All other bidders receive no points.

Examples: (1) The value equals 18,176 points. The price is 17,894. Thus, the payment of the highest bidder equals 18,176 - 17,894 = 282 points. (2) The value equals 5,874 points. The price is 6,345. Thus, the payment of the highest bidder equals 5,874 - 6,345 = - 471 points, i.e. if the price exceeds the value a loss results. (3) The value equals 8,785 points. The price is 8,785. Thus, the payment of the highest bidder equals 8,785 - 8,785 = 0 points.

Estimate: After the last stage you will be ask for your estimation of the valuation. Enter here, what you believe is the valuae.

Does the auction take place only once? There are a total of 16 auctions. The first 4 auctions are auction samples, i.e. these auctions will not affect your payments and are for practice purposes. In the next 12 auctions, your payoff is added and subtracted to your credit, respectively. At the end your current credit multiplied by 0.0056 will be disbursed.

What happens then? You take a seat at the terminal you were assigned by lots. If you have any questions, please raise your hands. After having finished all auctions, you will get your payoff. Please leave the instructions after the experiment at your place/terminal.

Good luck!