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Second-Chance Offers and Buyer Reputation: Theory and Evidence on Auctions with Default

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Abstract

Winners in online auctions frequently fail to complete purchases. Major auction platforms therefore allow "second-chance" offers, where the runner-up bidder pays his own bid price, and they let sellers leave negative feedback on buyers who default. We show theoretically that (i) all else equal, the availability of second-chance offers reduces bids; (ii) sellers have no incentive to exclude bidders, even if they are nearly certain to default; (iii) buyer reputation systems reward bidders with a reputation for defaulting, counter to the idea of deterring such behavior. Our auction experiments support these predictions and provide insights on their practical relevance.

JEL Classification: D44, C91, L14, D83

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1 Introduction

A major complaint of sellers in online auctions is that winning bidders often fail to pay and claim their item.[1] While auction platforms do not publish statistics on buyer default, posts by frustrated sellers speak a clear language.[2] Of course, a bid constitutes a legally binding contract. Yet in practice sellers can do little to enforce a bid, because legal debt collection procedures usually are infeasible or too costly.

Auction rules therefore often stipulate for the case where the winning bidder fails to pay that sellers may approach the second highest bidder with a take-it-or-leave-it offer, to buy at this bidder's highest bid price (see Online Appendix A). EBay, for example, calls this a *second-chance offer*. Additionally, auction platforms often try to deter defaults by letting sellers leave negative feedback on a buyer who fails to pay (see Online Appendix B).[3] Japan's largest online auction service Yahoo!, for example, automatically assigns the worst feedback score to a non-paying bidder (Yahoo!JAPAN, 2020a). In the present paper, we study theoretically and in laboratory experiments what the presence of second-change offers and buyer reputation systems imply for bidding behavior and seller revenues.

Second-chance offers do not only exist in online auctions, but arise in many other settings plagued by buyer default. In real estate markets, for instance, buyers often compete in an explicit auction or by bidding through estate agents, and there is a substantial likelihood that the winning bidder cannot secure the mortgage on which the deal is contingent. For example, the median mortage denial rate generally was 10 to 15 percent between 1990 and 2013 for a panel of lenders in the US covered by the Home Mortgage Disclosure Act that account for about 70 percent of all assets at domestically chartered banking institutions (Vojtech et al.,

[1]For example, 81 percent of negative seller comments in the sample of Dellarocas and Wood (2008, p.464) of over 50,000 eBay auctions relate to "bidders who back out of their commitment to buy the items they won". Accordingly, a guide book to selling writes "One of the most frustrating aspects of selling in eBay is dealing with winning bidders who don't pay" (Karp, 2005, p.236).

[2]A few examples. Anonymous [aaronf] (2015): *It's terrible. I bet half of my auction winners never pay.* Anonymous [Ragbutter] (2014): *30% of people don't even bother to pay and you can't do a dang thing about it. Sure - you can let eBay auto file a Non Paying Bidder Claim - SO? You still don't get your nmoney [sic].* Anonymous [toocool17] (2004): *I list up about 10-20 auctions a week, and I usually average 1 non paying bidder a week which is a pain.* Anonymous [aprilb27] (2012): *I have had 32 non payers in the last couple months, 5 this week alone. I wish we could leave negative feedback I really do think it would help.*

[3]Examining around 36,000 transactions on eBay, Resnick and Zeckhauser (2002) find that around 1 percent of them result in negative feedback for the buyers, with the most common complaint by sellers being that the winning bidder does not follow through on the transaction (eBay changed the feedback system since then to the system described in Online Appendix B).

2019, Fig.3). In these markets, second-chance offers typically are set at the amount bid by the runner-up bidder.[4] Even when this is not the case, the second-chance offer will likely be influenced by the expressed willingness to pay of the runner-up bidder.

Similarly, in take-over bids, firms may be reluctant to match a higher offer and reveal their value for the target, knowing that the directors of the target company may well reject the highest offer (Lipton, 1979, 2005). In that case, a runner-up bidder may be successful with a lower own bid.[5]

Our paper addresses the issue of buyer default both theoretically and experimentally. To model buyer default and second-chance offers, we consider a standard symmetric, independent, private value setting with sealed bids where the winner pays the second highest bid. In the absence of buyer default, it is optimal to bid one's value for the object. To this setting we add an *unreliable* bidder, who has a known probability of failing to complete the deal should he win the auction. The other bidders are *standard*, in the sense that they never default.

We show in our theoretical model how, surprisingly, the combination of second-chance offers and a buyer reputation mechanism may act to the detriment of sellers. Standard bidders bid lower in the presence of a bidder who might default than they otherwise would. Specifically, they trade-off the chance of becoming the highest bidder (in which case the buyer pays the second highest bid) with the possibility of buying the good more cheaply in the event of a second-chance offer after the winning bidder defaults (in which case the buyer pays his own bid).[6]

The reputation system reveals to auction participants whether a competing bidder is likely to default if he wins. This allows auction participants to adjust to the probability of default by how much they shade their bid relative to their willingness to pay. We show that, depending on the default probability, the seller's expected revenue may be higher or lower than in the absence of a reputation system.

Another key result of our model is that a buyer reputation system creates a strategic effect that rewards bidders who have a reputation for frequently defaulting, counter to the idea of

[4]In foreclosure auctions, for instance, mortgagees often explicitly reserve the right to sell the property to the second highest bidder if the highest bidder defaults. In some auctions, the second highest bidder even is automatically obliged to take the property at his highest bid price (e.g. Sheriff's Sale Notices, 2011). Yet, in contrast to online auctions, there are not always fixed rules for second-chance offers, which may additionally influence bidding strategies (see also Appendix A).

[5]A preferred lower alternative bidder is sometimes referred to as "White Knight". Two famous examples are Paramount's rejection of an offer from QVC that was much higher than Viacom's bid, and that of Revlon rejecting a bid of Pantry Pride in favor of a lower bid from Forstmann Little (for details see Kurp, 1995).

[6]Our arguments extend to a setting where all bidders have a symmetric default probability.

such systems deterring default. An unreliable bidder gains from having his poor reputation being made public because other bidders shade their bids in response to this information. Consequently, the unreliable bidder – when he wins the auction – pays a lower expected price than if the other participants in the auction were unaware of the bidder's poor reputation. Yet, counter to the common intuition about reputation systems, it is *not* optimal for a seller to exclude an unreliable bidder from the auction – even if the bidder is nearly certain to default. We show that the loss in expected revenue from removing the unreliable bidder exceeds the loss in expected revenue caused by bid shading in the presence of the unreliable bidder. The reason is that the unreliable bidder may end up submitting the second highest bid and his presence hence pushes up the expected price paid if a bidder wins who does not default.[7]

Since, in the theoretical model, the effect of a buyer reputation mechanism on the expected revenue depends upon parameter values, it is of interest to run experiments to get a sense of the empirical relevance of our predictions. Specifically, the optimal reaction to a competing bidder having a probability of defaulting is far from trivial to compute, making it likely that even if bidders grasp the intuitive incentive to lower their bid, they will not adjust optimally. As a result, the presence of second-chance offers and buyer reputation systems may have different effects in practice than in theory.

We run experiments based on a simple variant of our model with discrete values and bids. Subjects are assigned their role for the entire experiment and participate in 100 auctions, with feedback after each round. They either are a standard bidder who never defaults, or an unreliable bidder who has a commonly known, exogenously set probability of defaulting in case of winning the auction. Treatments vary the probability with which the unreliable bidder defaults, and we include a control treatment with no default (a standard second-price auction).

In line with our theoretical predictions, we find that unreliable bidders bid near the level of bids observed in the standard second-price auction control treatment, while standard bidders bid less. However, the bid differences that we observe across different default rates are small relative to those predicted by the theory. In particular, standard bidders respond mostly to

[7] A problem related to our research arises in first-price auctions if bidders are allowed to place multiple bids that they can withdraw without a fine after the auction. Here a bidder can place bids on a fine grid up to a level (below his value) that ensures that he wins. Subsequently, he can withdraw winning bids until reaching the minimum bid at which he still wins. If all bidders follow this strategy, this effectively turns a first-price auction into a second-price auction. If only one (or some) of the bidders follow this strategy, this lowers auction revenue. McMillan (1994) presents evidence for such multiple bids with repeated defaults from Australian spectrum auctions.

unreliable bidders who display a high default risk, and largely ignore the possibility of default if there is only a modest default risk.

Our experimental findings suggests that, in practice, (i) bidders might not respond to the typically low baseline probability of default in the population of bidders, (ii) but that they are likely to react to a specific, high default risk of a co-bidder that a reputation system singles out, by bidding less than they otherwise would. In fact, many buyers may not even consider the possibility that other bidders default unless a reputation system exists that makes them aware of the problem. Overall, this suggests that salient buyer reputation systems may have negative effects on seller revenue.

To our knowledge we are the first to model how buyer reputation affects bidding behavior.[8] There is considerable work on seller reputation (for an excellent survey see Tadelis, 2016). A number of papers investigate theoretically how – in the context of moral hazard or adverse selection – reputation building mechanisms for sellers can sustain a more efficient market outcome (e.g. Diamond, 1989; Kreps et al., 1982; Tadelis, 1999, 2002; Mailath and Samuelson, 2001) and can outperform litigation systems (Bakos and Dellarocas, 2011). Reputation building allows high quality sellers to differentiate themselves from lower quality ones and thus obtain higher prices for their goods. Experimental evidence shows that reputation mechanisms can indeed substantially increase the rate of successful transactions (e.g. Bolton et al., 2004). Studies using field data (mainly from eBay) generally find that a higher seller reputation translates into a higher price for the good and a higher sales rate (e.g. Ba and Pavlou, 2002; Melnik and Alm, 2002; Dellarocas, 2003; Bajari and Hortaçsu, 2004; Resnick et al., 2006; Lucking-Reiley et al., 2007). Other papers discuss how to improve reputation systems, for example, by providing incentives for informative reviews (e.g. Li et al., 2016) or by giving recent ratings more weight to ensure that sellers have an incentive to consistently behave honestly over time (Fan et al., 2005). Overall, the literature supports the wide-spread belief that providing information about traders' past behavior can help curtail bad behavior by market participants. This idea also underlies the reputation systems that we see on auction platforms and in other markets. Yet little is known about why a buyer should be concerned about his reputation, and how the reputations of competing buyers might affect the bidding outcome.[9]

[8] A few theoretical articles treat second-chance offers from a different angle. Here, the seller may possibly have multiple units that she can sell to runner-up bidders (Bagchi et al., 2014; Joshi et al., 2005; Garratt and Tröger, 2014). They do not consider buyer reputation.

[9] A separate issue is whether buyer and seller feedback systems might interact. Assuming that buyers have a preference for good feedback, Greiner et al. (2013) argue that sequential feedback by transaction partners may distort feedback if buyers fear retaliation by a seller.

Bilateral rating systems also characterize sharing economy platforms such as Uber and Airbnb, where customers rate service providers and these rate customers, instead of just a unilateral rating of sellers. Jin et al. (2018) argue that inuition would suggest that bilateral ratings in ride-hauling markets would hurt riders overall, as this will lead some riders with poor ratings to be rejected and the platform would extract value from ratings. Counter to that intuition, they show that bilateral ratings may in fact benefit customers and harm the platform provider. While the context and mechanisms are different from our auction setting, their study also shows that bilateral rating systems can have counter-intuitive effects.

There are three potential disciplining forces of a system that rates buyers. First, a good buyer reputation may facilitate entry as a seller (Tadelis, 1999). Cabral and Hortacsu (2006) provide some evidence for this on eBay. But if there are separate reputation measures for buyer and seller roles, it is not clear why the buyer score would matter in the seller role.[10]

Second, sellers might exclude buyers with a bad reputation. For example, the leading online auction sites eBay and Yahoo!Auctions Japan allow sellers to block buyers who have a low feedback score or a history of unpaid items (eBay, 2020; Yahoo!JAPAN, 2020b). Yet, as we show, sellers will not have an incentive to do so because excluding any potential buyer lowers expected revenue, even if that buyer has a high probability of defaulting.[11]

Third, a bad reputation may be harmful because of the way other bidders respond to the reputation of a co-bidder. Yet, as we show, the strategic effect of a bad reputation on other bidders actually favors a bidder who has a reputation for defaulting. Specifically, the unreliable bidder always gains from having his type revealed to other bidders, as this encourages them to shade their bids. While we do not explicitly model the strategic acquisition of a reputation for defaulting, we find examples where acquiring such a credible reputation for defaulting does pay off. Here, for a sufficiently low default probability, it is better to be in the position of the unreliable bidder than to be a standard bidder. The reason is that bid shading by standard bidders lowers the expected price that the unreliable bidder pays when winning and that in expectation this benefit exceeds the foregone net gain ($value - price$) in case of the occasional default.

[10] For example, eBay posted a separate feedback score for transactions as a buyer next to the seller reputation score from 2001 to 2008. But even with the reputation system implemented after 2008, the reliability of a buyer can easily be assessed by other market participants by reviewing the number of times the user has retracted bids in the past (see Online Appendix B).

[11] We abstract from transaction costs of dealing with a bidder who defaults, as these are quite low in online markets. They may be significant enough in other settings, though, to provide a rationale for excluding bidders who are likely to default. An example are procurement auctions, where bidders are typically pre-qualified based on firms' characteristics like technical and financial capacity and history of completed projects.

In the next section, we present the theoretical model and its predictions. Section 3 contains the experimental design and hypotheses. Experimental results are presented in Section 4, followed by a concluding discussion in Section 5.

2 The model

A single object is for sale in a second-price, sealed-bid auction with the possibility of a second-chance offer. There are $N > 2$ risk neutral bidders, one of whom has a reputation for being unreliable.[12] Bidder N is the *unreliable* bidder, who is known to default with probability $\delta \in (0, 1)$ if he wins the auction.[13] The remaining bidders $i = 1, \ldots, N - 1$ are *standard* bidders, who never renege on their bids. Each bidder $i = 1, \ldots, N$ assigns a value of v_i to the object. Values v_i are independently and identically distributed according to distribution function F, which is assumed to have a density f that is positive and continuous on $[0, 1]$ and equals zero elsewhere. In addition, we impose the standard monotone hazard rate property that $\frac{1-F(v)}{f(v)}$ is non-increasing.

After observing their values, bidders submit their bids. The highest bidder wins the auction. If a standard bidder places the highest bid, then the transaction is completed at the price equalling the second highest bid. If the the unreliable bidder N places the highest bid, the transaction is only completed with probability $1 - \delta$. With probability δ, the bidder defaults and has a zero payoff. The seller then makes a second-chance offer to the second highest bidder, who receives a take-it-or-leave-it offer to buy the object at his own bid. If the runner-up bidder does not complete the transaction, no sale occurs. Whenever there is a tie, the winner is randomly selected.

Note first that for the unreliable bidder N it is a weakly dominant strategy to bid his own value. The default probability does not depend on his bid and other bidders do not default. So for him the same logic applies as in the standard second-price, sealed-bid auction with private values, where it is a weakly dominant strategy to bid one's own value. It seems

[12] The predictions of the model extend also to $N = 2$. Then bid shading can become even more extreme, because a standard bidder bidding zero will win the object with probability δ (the probability that the unreliable bidder defaults), which dominates positive bids for sufficiently high δ. Instead of cluttering the proofs with case distinctions that capture the bid function being discontinuous in δ for $N = 2$, we cover this case by explicitly deriving equilibrium strategies for an example with uniformly distributed values below.

[13] Default is not a choice variable of the unreliable bidder, but occurs as a result of an exogenous shock that is independent of the unreliable bidder's value and bid. For simplicity, our model has just one unreliable bidder. But the basic insights about bid shading readily extend if all bidders may default with a probability δ (cf. footnote 21 in the proof of Proposition 1).

reasonable that bidders expect positive bids to win with positive probability, and that this is common knowledge. This rules out that players use weakly dominated strategies (Battigalli and Siniscalchi, 2003). We hence consider equilibria in undominated strategies, i.e., where the unreliable bidder N bids his value.

Assumption 1 (Regular equilibria) *We consider Perfect Bayesian equilibria where the unreliable bidder N bids his value and the standard bidders $i = 1, \ldots, N-1$ bid according to a symmetric, increasing bid function $\beta(v_i)$.*

The next result describes properties of the equilibrium bid function β of standard bidders $i = 1, \ldots, N-1$. All proofs are in the appendix.

Proposition 1 (Equilibrium bids)

(i) *For $\delta \in (0,1)$, standard bidders bid's are strictly increasing in value and, except for $v_i = 0$ and $v_i = 1$, they bid strictly less than their value: $\beta(v_i) < v_i$ for $v_i \in (0,1)$.*

(ii) *For $\delta \in (0,1)$, any regular equilibrium is unique.*

(iii) *For $\delta = 0$, all bidders bid as in the symmetric equilibrium of the standard second-price, sealed-bid auction with N bidders.*

(iv) *For $\delta = 1$, standard bidders bid more than they would in the symmetric equilibrium of the standard first-price, sealed-bid auction with $N-1$ bidders.*

By standard arguments, $\beta(0) = 0$ and $\beta(1) \leq 1$. It is a dominated strategy for the standard bidders to bid above their value. This implies that a second-chance, take-it-or-leave-it offer equal to the runner-up's own bid is always accepted. As a result, with some chance a standard bidder wins the auction outright and pays the second highest bid, and with some chance he ends up paying his own bid, because he receives a second-chance offer after the unreliable bidder won the auction and defaulted. Intuitively, the second-chance offer introduces an element of a first-price auction into the game. As a result, standard bidders bid below their value: shading their bid allows them to obtain a gain in payoff after a second-chance offer that outweighs the reduction in the probability of winning the auction outright. Note however that the first-price auction is not a limiting case as the default probability $\delta \to 1$. The reason is that for $\delta = 1$ bidders only end up paying their own bid if the unreliable bidder wins the auction and defaults, otherwise the price still is equal to the second highest bid.

Independent of whether default occurs or not, the price ultimately paid is always equal to the second highest bids in the original list of submitted bids. Nevertheless, the possibility that a bidder may default is harmful for the seller. Bids of standard bidders are lower than in a standard N-bidder second-price auction where everyone bids their own value. Hence, expected revenue is lower. The higher the probability of a default, the greater the extent of bid shading and the lower the revenue.

Proposition 2 (Expected revenue) *The presence of an unreliable bidder with default probability $\delta \in (0, 1]$ next to $N-1$ standard bidders strictly lowers the expected revenue for the seller relative to the symmetric equilibrium of the standard N-bidder second-price auction. Expected revenue is decreasing in δ.*

Three studies that we are aware of link buyer reputation to auction revenue (as a side line to their main focus). Dewan and Hsu (2001), Durham et al. (2004), and Houser and Wooders (2006) consider the correlation between winning buyers' reputations and prices on eBay. They find either the negative correlation predicted by our model, or no significant correlation.

It is tempting to think that the underbidding problem could be resolved under a modified auction procedure: After a default the new winner is charged the bid of the remaining runner-up, i.e. the third highest bid in the original list of submitted bids. Intuitively, this procedure preserves the 'second-price feature' even after default, in the sense that the winner after default never pays his own bid. This intuition, however, is misleading. A standard bidder will still shade his bid and risk losing against the unreliable bidder to increase the chance of getting the good at the low third-bid price in the event of a default (see Appendix A). The key problem is that bidding below one's value allows a bidder to obtain the good at a lower price with some probability. In our model, the runner-up's own bid determines what the price is after a default. With the modified auction procedure, bidding less can result in paying less, because after a default the bidder only pays the third highest bid rather than the second highest bid he would have to pay when winning outright.

We have shown that bid-shading occurs in the presence of an unreliable bidder. A reputation system, however, gives the seller an opportunity to exclude bidders who are likely to default from the auction. As mentioned in the introduction, eBay and Yahoo!Japan, for example, allow sellers to block buyers with a poor feedback score. Yet, our next result shows that a seller has no incentive to exclude an unreliable bidder, even if the bidder is nearly certain to default after winning.

Proposition 3 (Non-optimality of bidder exclusion) *It is not optimal for the seller to exclude the unreliable bidder. For any $\delta \in (0, 1)$, the seller's expected revenue strictly decreases when the unreliable bidder is excluded.*

While different from the well-known result of Bulow and Klemperer (1996) about the value of an additional bidder, our result has a flavor of their finding. They establish that, under mild conditions, expected revenue is higher with one extra bidder in a standard auction without reserve price than if the seller sets an optimal reserve price. So in particular, revenue is higher than with a stochastic reserve price. In the limiting case of our model where $\delta = 1$, we can think of the unreliable bidder's bid as such a stochastic reserve price. For $\delta = 1$, the auction is revenue equivalent to an auction with the unreliable bidder excluded. As the revenue is decreasing in δ, the seller is better off not excluding the unreliable bidder as long as $\delta < 1$.

Having established that the seller is made worse off by the possibility of a bidder defaulting, we now turn to the bidders' payoffs. Standard bidders gain from the fact that one of the other bidders is an unreliable bidder. Compared to a standard second-price, sealed-bid auction, the presence of an unreliable bidder makes all standard bidders bid less aggressively. Thus, in expectation they pay a lower price whenever they win (either directly or after a default). The unreliable bidder gains from having revealed to other bidders that he has a default probability $\delta > 0$: the seller will not exclude him from the auction and, because the standard bidders shade their bids, he wins more often and pays a lower price whenever he wins than if the other bidders thought he would never default. The next result summarizes our findings about the comparative statics in equilibrium payoffs.

Proposition 4 (Bidders' payoffs)

(i) The standard bidders are always better off from the N^{th} bidder being an unreliable bidder with default probability $\delta > 0$ rather than another standard bidder.

(ii) The standard bidders' expected payoff is strictly increasing in δ.

(iii) The unreliable bidder is always better off if a reputation system makes his reputation for defaulting common knowledge relative to the situation where the other bidders think they are bidding against another standard bidder.

Can the unreliable bidder even be better off than if he just was another standard bidder who never defaults? Consider the thought experiment of committing to a default probability $\delta > 0$. The downside, of course, is that in the event of a default the bidder loses the net benefit $v - price \geq 0$. On the other hand, having a (commonly known) probability of defaulting makes other bidders bid less aggressively. Which of the two effects dominates depends on the parameters of the model. As shown in Figure 2, at least for small δ, the higher chance of winning and the lower price conditional on winning dominate the occasional loss due to a

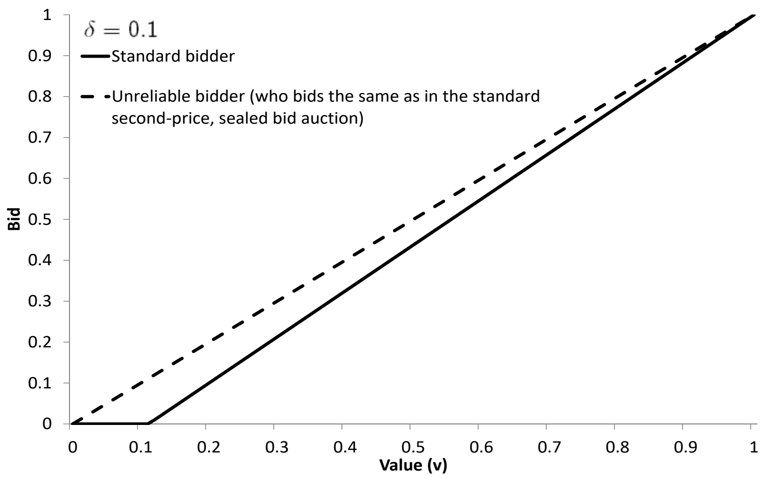

Figure 1: Bid functions for $\delta = 0.1$

default in our example below of two bidders with uniformly distributed values (and also in the auction parameterizations used for the experiments). That is, if the unreliable bidder could choose his default probability, he would commit to some $\delta > 0$ rather than chose never to default.

To illustrate our above results we consider a two-bidder example with uniform distribution of values on $[0, 1]$, which admits an explicit solution:

Example: Two bidders with uniformly distributed values.
The standard bidder's equilibrium bid function is given by

$$\beta(v) = \begin{cases} 0 & v \leq \frac{\delta}{1-\delta}, \\ \frac{(1-\delta)v-\delta}{1-2\delta} & v > \frac{\delta}{1-\delta}. \end{cases}$$

Note that $\beta(v) = 0$ *for all* v *if* $\delta \geq 1/2$*. The expected payoffs* Π_S *for the standard bidder and* Π_δ *for the unreliable bidder, respectively, are*

$$\Pi_S = \begin{cases} \frac{1}{6}\left(1 + \frac{\delta^2}{1-\delta}\right) < \frac{1}{6}(1+\delta) = \Pi_\delta & \text{for } \delta < 1/2, \\ \frac{1}{2}\delta > \frac{1}{2}(1-\delta) = \Pi_\delta & \text{for } \delta \geq 1/2. \end{cases}$$

We graph the bid functions for $\delta = 0.1$ in Figure 1.[14] Note that for all values in $(0, 1)$ the standard bidder underbids relative to his value. The expected payoffs for the two bidders are

[14] The two-bidder case is special because the lone standard bidder will not bid according to a strictly increasing bid function, but will bid 0 for low values. The key qualitative properties, however, match those for $N > 2$.

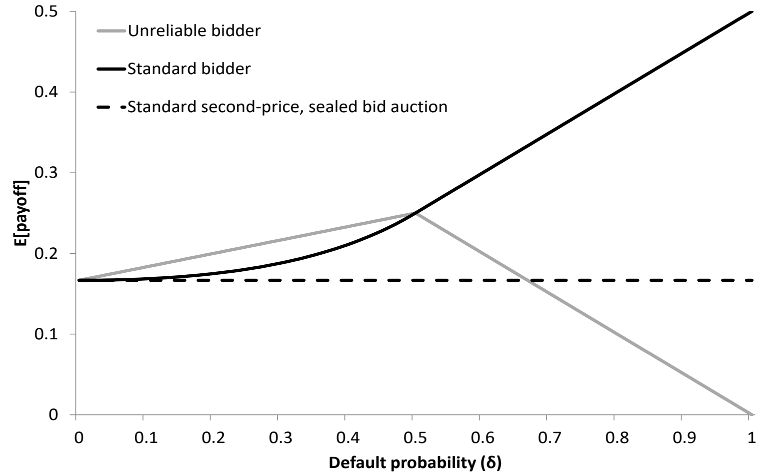

Figure 2: Expected payoffs

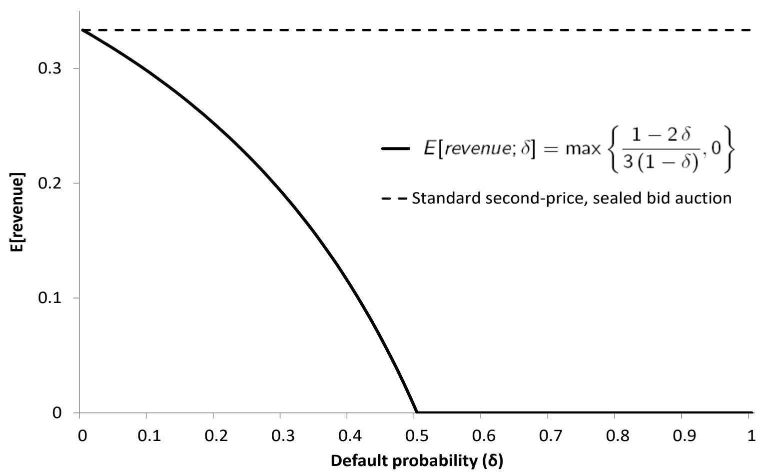

Figure 3: Expected revenue

shown in Figure 2. For low (high) default rates, the unreliable (standard) bidder achieves a higher expected payoff than the other bidder. The standard bidder is always better off than in a standard second-price, sealed bid auction. For a sufficiently low default probability, the unreliable bidder is better off than if he had a zero default probability (in which case, both bidders would achieve the expected payoff from the standard second-price, sealed bid auction). This example illustrates why, if a bidder could choose his default probability, he may commit to some $\delta > 0$ rather than chose never to default. Figure 3 shows how the expected revenue for the seller declines with the default rate. Here it is trivial that the seller would not wish to exclude the unreliable bidder, because the single remaining bidder would bid 0.

Our two-bidder example also shows that it may actually be better for the seller to eliminate the possibility of second-chance offers altogether. The expected revenue with a second-chance offer here is $\max\left\{\frac{1-2\,\delta}{3\,(1-\delta)}, 0\right\}$. Now suppose that there is no second-chance offer. In the most unfavorable case for the seller, there is no sale after a default and she makes zero profits. But bidders will bid their value and only with probability $\delta/2$ will the outcome be that the unreliable bidder wins and defaults. Otherwise the revenue is as in the standard second-price auction. That is, expected revenue is $(1-\delta/2)\,\frac{1}{3}$, which exceeds the expected revenue with a second-chance offer for any $\delta \in (0,1)$.[15]

Example (cont'd): Second-chance offers may be suboptimal.

In the two-bidder example with uniformly distributed values, for any $\delta \in (0,1)$ the seller has higher expected revenue if she does not sell the object after a buyer defaults than if she commits to a second-chance offer.

Are systems that publicize buyer reputation a good idea for sellers? From a theoretical perspective, there is no clear prediction whether the seller's revenue is higher with or without a reputation system. Again, this is easily illustrated with our 2-bidder example.

Example (cont'd): (Non-)optimality of a reputation system.

In the two-bidder example with uniformly distributed values, for $\delta \sim U[0,0.5]$ ($\delta \sim U[0,1]$) the expected revenue of the seller is higher (lower) if the default probability δ of the unreliable bidder is not made known to the standard bidder. The seller's expected revenue

(i) *without a reputation system is*

for $\delta \sim U[0,0.5]$: $\quad E[revenue; \delta \sim U[0,0.5]] = E[revenue; E[\delta] = 0.25] = \frac{2}{9} \approx 0.222;$

for $\delta \sim U[0,1]$: $\quad E[revenue; \delta \sim U[0,1]] = E[revenue; E[\delta] = 0.5] = 0;$

[15] $(1-\delta/2)\frac{1}{3} > \frac{1-2\,\delta}{3\,(1-\delta)} \iff (1-\delta/2)(1-\delta) > 1-2\,\delta \iff 1-\frac{3}{2}\delta+\frac{1}{2}\delta^2 > 1-2\,\delta$, which holds for any $\delta > 0$.

(ii) *with a reputation system is*

$$\text{for } \delta \sim U[0,0.5]: \quad E[revenue; \delta \text{ known}] = \int_0^{0.5} E[revenue; \delta]\, d\delta = \tfrac{2}{3}\,(1 - \ln(2)) \approx 0.205;$$

$$\text{for } \delta \sim U[0,1]: \quad E[revenue; \delta \text{ known}] = \int_0^{1} E[revenue; \delta]\, d\delta = \tfrac{1}{3}\,(1 - \ln(2)) \approx 0.102.$$

If $\delta \sim U[0, 0.5]$ it is better that the precise default probability of the unreliable bidder is not made known, because the average default probability is low and the standard bidder responds to a high revealed δ with extreme bid shading. In contrast, if $\delta \sim U[0, 1]$, the average default probability is so high that rather than trying to win outright it is better for the standard bidder to bid zero and hope for getting the object after a default. As a result, the seller benefits from having a reputation system that can single out cases where the unreliable bidder actually has a low default probability and where it pays for the standard bidder to submit a positive bid to try to win outright.

3 Experiments

3.1 Design

For implementation in laboratory experiments, we turn to a model with discrete values and either two or three bidders. The equilibrium strategies are straightforward to derive, and have the same general properties that hold in the model with continuous values (see the Online Appendix).

The two-player design involved matching groups of six, with three standard bidders and three unreliable bidders. Players kept their roles throughout the session. The experiment had 100 auctions divided into two parts with a change in instructions after the 50th round.[16] Players were randomly matched in each round with a player of a different type within the matching group, and were randomly assigned a value of 0, 2, or 4. The matchings and values were drawn before the experiment and kept identical across treatments. We used the strategy elicitation method (Selten, 1967). Each player had to indicate how much he would like to bid conditional on each of the three possible values, before learning his or her actual value for the round. Permissible bids were restricted to the integers between 0 and 5. There was feedback after each round and subjects were paid for all 100 auctions.

The experiment was run at the Experimental Economics Laboratory at Royal Holloway, University of London using z-Tree (Fischbacher, 2007) and 144 students participated in six sessions that lasted on average 2 hours. They earned on average GBP 18.17. Three treatments with

[16] In the beginning, players were informed that there would be a break after 50 rounds and a change in instructions, but they were not told which sort of change there would be.

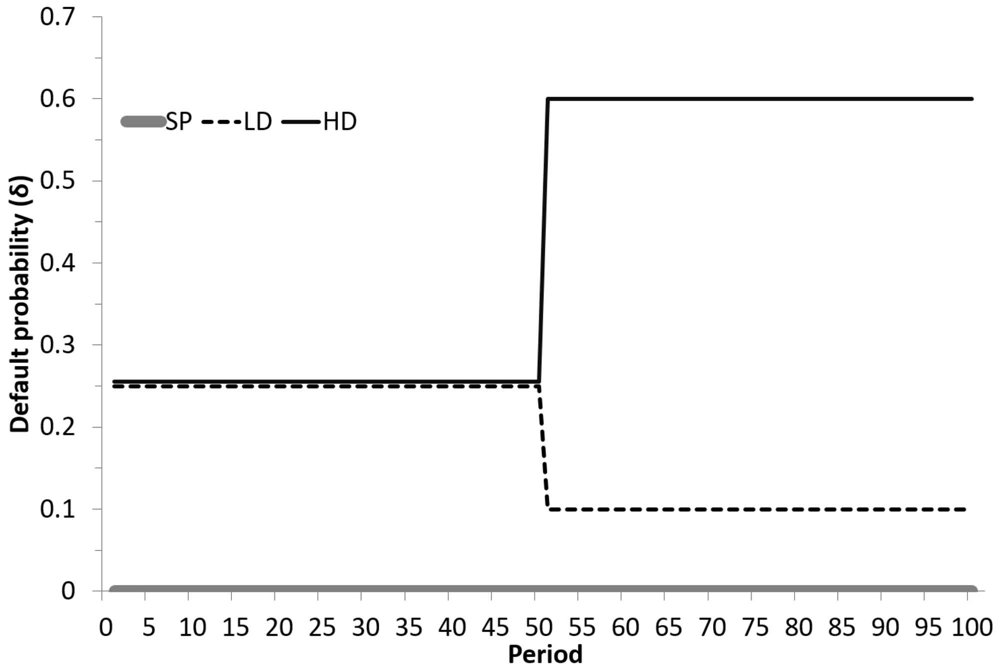

Figure 4: Treatment variation in the default probability for the unreliable bidder

48 subjects each were implemented, which differed only in terms of the default probability. As shown in Figure 4, both *HD* (high default) and *LD* (low default) had a default probability of 25 percent for the first 50 rounds, and then 60 percent and 10 percent, respectively, for the remaining 50 rounds. A treatment with no default probability was implemented as baseline, which is simply a standard second-price, sealed bid auction (*SP*). The three-bidder design was analogous and here 144 students participated in 16 sessions. For conciseness, we restrict attention to the two-bidder experiments. The findings from the three-bidder experiments are similar and we relegate details to the Online Appendix, which also contains the instructions given to subjects in the experiments.

3.2 Hypotheses

We test directional hypotheses implied by our theoretical results. Our hypotheses concern differences in bidding between standard and unreliable bidders and how their bids are affected by a change in the probability of default in the auction. To establish a benchmark, for each bidder type we also compare their bids relative to the bids in a standard second-price, sealed bid auction. We do not expect actual bids to precisely match point predictions from the theoretical equilibrium bids (see Table 1). In particular, it is well documented that substantial overbidding relative to a bidder's value occurs even in standard second-price auctions (e.g.

Default probability	Equilibrium bid $\beta(v)$ for			bid shading: $\beta(v)$ - (SP^a bid)		
	$v = 2$	$v = 4$	average^b	$v = 2$	$v = 4$	average^b
SP ($\delta = 0$)^a	2	4	3	–	–	–
$\delta = 0.25$	1	3	2	-1	-1	-1
$\delta = 0.10$	1	3	2	-1	-1	-1
$\delta = 0.60$	0	0	0	-2	-4	-3

Notes: All bidders with value zero bid zero. The unreliable bidder bids as in the standard second-price auction (SP). See the Online Appendix for derivations of equilibria.

[a] Second-price auction. [b] Average equ. bid for $v = 2, 4$.

Table 1: Equilibrium bids for standard bidders

Cooper and Fang, 2008), making treatment *SP* an important empirical benchmark for our exercise. Our preferred specification uses the average bid on values 2 and 4 as dependent variable (because all should bid 0 for value 0). We provide a more detailed analysis of bidding behavior separated by values in the Online Appendix.

Hypothesis 1 (Comparative statics for a given bidder type)

(i) Unreliable bidders' bidding behavior is independent of the default probability δ.

(ii) Standard bidders' bids for values 2 and 4, respectively, are decreasing in δ (weakly so for δ between 0.25 and 0.1).

Hypothesis 2 (Comparison across bidder types)

Standard bidders bid less compared to unreliable bidders for values 2 and 4, respectively, and this difference is increasing in the default probability δ (weakly so for δ between 0.25 and 0.1).

Hypothesis 3 (Comparison with bidding in a standard second-price auction)

(i) For any default probability, unreliable bidders bid like players in a standard second-price auction.

(ii) For $\delta \in \{0.6, 0.25, 0.1\}$, standard bidders' bids for values 2 and 4, respectively, are lower compared to bids in a standard second-price auction.

Hypothesis 3 is based on comparing bids with bids in a standard second-price auction. Note that it is related to the first two hypotheses, because 3(i) implies Hypothesis 1(i) and 3(ii), in conjunction with 3(i), implies the first part of Hypothesis 2.

4 Results

From the summary statistics for bids in Table 2 one already can see that standard bidders tend to bid lower than unreliable bidders, and that this effect is most pronounced for the high default probability $\delta = 0.6$. Further, and in line with previous auction experiments, there is evidence of overbidding in the standard second-price auction setting. Bidding in the other treatments should hence be considered relative to this empirical benchmark.

The regression analysis in Table 3 addresses our hypotheses by considering the average of the bids for values 2 and 4 of each player in each round (recall that subjects submit a strategy specifying a bid for values 0, 2, and 4).[17][18] Our identification strategy relies on comparisons within and across bidder types.

Hypothesis 1 concerns the effect of varying default probabilities, which we obtain by comparing bidding behavior in treatments *LD* and *HD* during the first 50 rounds ($\delta = 0.25$) with that during the last 50 rounds in the respective treatments ($\delta = 0.1$ or $\delta = 0.6$). Specifically, dummies for $\delta = 0.1$ and $\delta = 0.6$ capture the effects of a change in default probability relative to the omitted category $\delta = 0.25$. Because we exploit variation in δ within subjects we can here control for individual fixed effects.

For the unreliable bidder, specification (1) reveals no effect of a low default probability (dummy $\delta = 0.1$) relative to the reference category $\delta = 0.25$, but – contrary to Hypothesis 1(i) – a positive coefficient on the dummy for a high default probability $\delta = 0.6$. This is probably due to frustration caused by frequent default at $\delta = 0.6$, leading unreliable bidders to try and win *sometimes* by bidding aggressively.

For standard bidders, specification (2) reveals a significant negative coefficient on the dummy $\delta = 0.6$, in line with our Hypothesis 1(ii) that bids decrease when the default probability rises from $\delta = 0.25$ to $\delta = 0.6$. However, we find no significant effect for the low default probability dummy $\delta = 0.1$ relative to the reference category $\delta = 0.25$. Note that $\delta = 0.25$ always occurred in the first block (auctions 1-50) and the treatment difference $\delta = 0.1$ or $\delta = 0.6$ occurred in the second block (auctions 51-100). Comparisons between $\delta = 0.25$ and $\delta = 0.1$ or $\delta = 0.6$ hence may be confounded with experience effects. However, the reactions of standard bidders

[17] Results are robust to using a tobit model that accounts for the constraint that bids must lie between zero and five. Additional results for three-bidder auctions are qualitatively similar. See the Online Appendix, where we also present a more detailed analysis of bidding behavior separated by values.

[18] Our estimations use standard errors clustered at matching group level. Cameron and Miller (2015) discuss inference problems that may arise if there are less than 50 clusters, as is in our case. To address this, they propose a wild cluster bootstrap procedure. We also report these non-parametric standard errors (obtained using the STATA program `cgmwildboot` of Cameron et al. (2008)). All our findings are robust.

Default probability	Value	Part 1 (periods 1-50)			Part 2 (periods 51-100)		
		0	2	4	0	2	4
$\delta = 0^a$		1.00	2.88	4.30	0.75	2.75	4.40
(SP)		(1.18)	(0.95)	(0.78)	(0.99)	(0.88)	(0.78)
	Obs.	2400	2400	2400	2400	2400	2400
$\delta = 0.25$	UBidder[b]	0.92	3.02	4.50	–	–	–
(LD & HD)		(1.24)	(1.14)	(0.81)	–	–	–
	SBidder[c]	0.99	2.77	4.27	–	–	–
		(1.25)	(1.21)	(1.14)	–	–	–
	Obs.	2400	2400	2400	–	–	–
$\delta = 0.10$	UBidder	–	–	–	0.57	2.83	4.36
(LD)					(1.06)	(1.10)	(0.92)
	SBidder	–	–	–	0.87	2.78	4.31
					(1.21)	(1.23)	(1.11)
	Obs.	–	–	–	1200	1200	1200
$\delta = 0.60$	UBidder	–	–	–	0.64	3.15	4.72
(HD)					(0.93)	(1.05)	(0.52)
	SBidder	–	–	–	0.35	1.64	3.15
					(0.80)	(1.16)	(1.90)
	Obs.	–	–	–	1200	1200	1200

Notes: Average bids. Standard deviation in parentheses. [a] Second-price auction. [b] Unreliable bidder. [c] Standard bidder. 144 subjects (48 subjects per treatment).

Table 2: Summary statistics for average bids

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	UvsU[a]	SvsS[a]	UvsS	UvsS	UvsSP[a]	SvsSP[a]
SP[a]					omitted category	
$\delta = 0.1$	-0.130	-0.149	-0.071	0.024	0.017	-0.031
	(0.10) [0.12]	(0.22)[0.15]	(0.09)[0.19]	(0.18)[0.19]	(0.20)[0.28]	(0.23)[0.22]
$\delta = 0.25$		omitted category			0.169	-0.068
					(0.11)[0.11]	(0.14)[0.13]
$\delta = 0.6$	0.142	-0.957	-0.477	-1.130	0.360	-1.185
	(0.05)**	(0.26)***	(0.11)***	(0.22)***	(0.11)***	(0.24)***
	[0.07]**	[0.31]***	[0.15]***	[0.37]***	[0.15]**	[0.39]***
UBidder[b]			0.517			
			(0.20)**			
			[0.23]**			
$\times\delta = 0.1$[c]				0.047		
				(0.31)[0.26]		
$\times\delta = 0.25$[c]				0.237		
				(0.15)[0.16]		
$\times\delta = 0.6$[c]				1.545		
				(0.24)***		
				[0.00]***		
Constant	3.760	3.523	3.288	3.522	3.296	3.284
	(0.03)***	(0.06)***	(0.14)***	(0.11)***	(0.11)***	(0.10)***
	[0.00]***	[0.00]***	[0.00]***	[0.00]***	[0.00]***	[0.00]***
Bidder FE	Yes	Yes	No	No	No	No
Period FE	No	No	No	No	Yes	Yes
R^2	0.016	0.157	0.099	0.177	0.033	0.154
Obs.	4800	4800	9600	9600	9600	9600

Notes: Robust standard errors in parentheses (clustered at matching group level) [nonparametric wild cluster bootstrap]. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. [a] U: unreliable bidder, S: standard bidder, SP: second-price auction ($\delta = 0$). [b] Dummy for unreliable bidder. [c] Interaction effects unreliable bidder $\times$ default probability.

Table 3: Regressions for average bids on values 2 and 4

to an increase from $\delta = 0.25$ to $\delta = 0.6$ and to a decrease from $\delta = 0.25$ to $\delta = 0.1$ are significantly different, and in line with the predictions of our model.

Result 1 (Comparative statics for a given bidder type)

(i) The high default probability $\delta = 0.6$ leads unreliable bidders to bid (weakly) higher for values 2 and 4, respectively, compared to $\delta \in \{0.1, 0.25\}$, for which bids do not differ significantly.

(ii) Standard bidders' bids for values 2 and 4, respectively, are lower with the high default probability $\delta = 0.6$, compared to $\delta \in \{0.1, 0.25\}$, for which bids do not differ significantly.

For the comparisons across bidder types, our identification relies on between-subject variation in bidding behavior for a fixed default probability, i.e. within a block of auctions (first or last 50 rounds). In line with Hypothesis 2, we find a significant positive coefficient on the dummy for unreliable bidders in specification (3) of Table 3. Specification (4) shows that the effect is driven by differences in bidding behavior between unreliable and standard bidders at the high default probability $\delta = 0.6$. Specifically, the interaction effect $UBidder \times [\delta = 0.6]$ is positive and significantly different from 0, whereas the interaction effects $UBidder \times [\delta = 0.1]$ and $UBidder \times [\delta = 0.25]$ are not significantly different from zero.

Result 2 (Comparison across bidder types) *For the high default probability $\delta = 0.6$, standard bidders bid less than unreliable bidders do for values 2 and 4. For $\delta \in \{0.1, 0.25\}$ we cannot reject that average bids are the same across both bidder types.*

We now compare bidding behavior with that in the standard second-price, sealed-bid auction treatment *SP*. Comparisons with the omitted category *SP* allow for period fixed effects to control for possible experience effects. In specification (5) of Table 3 the dummy $\delta = 0.6$ has a significant positive coefficient. That is, for the high default probability, unreliable bidders place higher bids than subjects in the standard second-price auction treatment do, inconsistent with Hypothesis 3(i). As mentioned before, this probably is due to unreliable bidders increasing their bids because of frustration about not winning the object on account of frequent default. Consistent with Hypothesis 3(ii), we find in specification (6) a significant negative coefficient on the dummy $\delta = 0.6$. That is, standard bidders shade their bids relative to the standard second-price auction when the default probability is high - in line with Results 1 & 2. Note that the overbidding of unreliable bidders for $\delta = 0.6$ is much weaker than the underbidding of standard bidders.

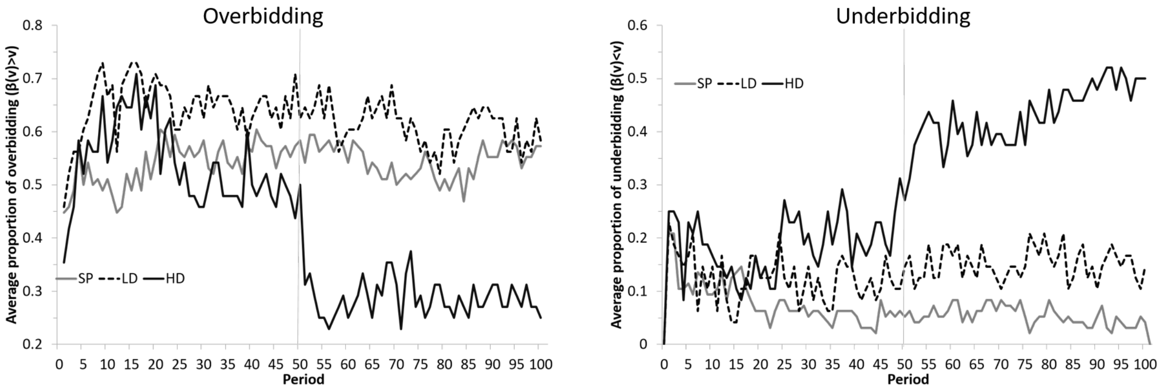

Figure 5: Comparison of empirical frequency of under/overbidding by standard bidders

Result 3 (Comparison with bidding in a standard second-price, sealed bid auction)

(i) Unreliable bidders' bids for values 2 and 4 are as in the standard second-price auction, except for the high default probability $\delta = 0.6$, where they are significantly higher.

(ii) Standard bidders' bids for values 2 and 4 are as in the standard second-price auction, except for the high default probability $\delta = 0.6$, where they are significantly lower.

As is common in auction experiments, we find a lot of overbidding relative to value. This suggests that there can be two reasons why bids are lower in the presence of an unreliable bidder: either participants overbid less than in the second-price auction, or – in line with our model – they underbid more relative to their value. Figure 5 shows that both effects matter. It graphs the average proportion of bids for values 2 and 4 with bids higher than the value (overbidding) and with bids lower than the value (underbidding) for each period for subjects in the second-price auction and for standard bidder subjects in treatments *LD* and *HD*. For periods 1-50, we tend to see little systematic difference in over-/underbidding between *LD* and *HD* (in both, the default probability $\delta = 0.25$), as confirmed by a regression with a linear trend for periods 1-50 and treatment dummies ($p > 0.25$). But they both tend to have more over- and underbidding relative to treatment *SP* ($p < 0.016$). For periods 51-100, we see a sharp increase in underbidding in *HD* ($\delta = 0.6$) relative to both *LD* ($\delta = 0.1$; $p = 0.002$) and *SP* ($p < 0.001$), and a sharp decrease in overbidding in *HD* relative to both *LD* ($p = 0.013$) and *SP* ($p = 0.027$). There is no significant difference between *LD* and *SP* for either measure ($p > 0.122$). Overall, a high default probability appears to make standard bidders learn to underbid and not to overbid relative to their value.

In our additional experiments with three-bidders, we find similar patterns (see the Online Appendix for details). For a high default probability ($\delta = 0.6$, standard bidder subjects tend to underbid relative to the empirical benchmark situation of a second-price auction, but they respond little to lower default probabilities.

5 Conclusion

Second-chance offers may appear attractive because they are ex-post revenue maximizing. If the highest bidder drops out because of a default, any new auction would yield no higher offers than the current second highest bid, the price at which the second-chance offer is made. This argument, however, ignores the strategic effect that second-chance offers have *ex ante* because bidders take into account the option of a second-chance offer and adapt their bidding behavior. Our theoretical results reveal that second-chance offers give bidders an incentive to shade their bids, and hence are not a cost-less remedy to the possibility of ending up with not selling in case of default by the winning bidder. In fact, it may even be better for the seller to eliminate the possibility of second-chance offers altogether (as illustrated with a concrete example for our model).

So are systems that publicize buyer reputation a good idea for sellers? From a theoretical perspective, there is no clear prediction whether the seller's revenue is higher with or without a reputation system (again, we illustrated this with concrete examples). Our experiments offer additional insights that make it possible to draw more specific conclusions. We find that – in line with the theoretical predictions – bidders respond to a high probability of default by shading their bids. Yet, for low default probabilities, bidders do not seem to be affected by the possibility of another bidder defaulting and bid as they would in a standard second-price auction.

This suggests that buyer reputation systems actually may be harmful for the seller. They alert bidders to cases where the probability of a default is high and trigger bid shading in the auction at hand. In the absence of a reputation system, bidders are not likely to be much influenced by the typically moderate baseline probability of default in the population of bidders. In addition, the seller cannot do much with the information that a buyer has a high probability of default, because excluding such a bidder is not profitable. While we did not explicitly model the strategic acquisition of a reputation for defaulting, we provide examples that it pays off to have a reputation for defaulting with some probability. Such incentives to strategically acquire a reputation for defaulting create additional feedback effects that may worsen the problem of default in the presence of a buyer reputation system. A study by Klein et al. (2016) also suggests that moving away from a buyer reputation system does not harm market performance: After eBay in 2008 abolished explicit buyer reputation scores, there was no increase in seller exit and buyer satisfaction with seller performance even increased.

Appendix

A The second-chance offer mechanism: Further considerations

A.1 A third-price rule does not solve the underbidding problem

An intuitive suggestion to remedy the underbidding problem caused by second-chance offers is to let the runner-up bidder pay not his own bid but the third highest bid (i.e., the second highest of the remaining bids after the default). The underlying idea is to let standard bidders compete in a second-price auction if a default occurs, in order to give them an incentive to bid their own value. This intuition turns out to be false because the third-price rule after default also leads to underbidding: if I know that after a default I only pay the third highest bid when being the runner-up, this creates an incentive not to try to beat the unreliable bidder, but rather go for being the runner-up.

To see more formally, why this will lower the expected price that I have to pay, consider bidding $v - \epsilon$, with ϵ small. If I bid v instead, there are three relevant constellations, where this change in bids makes a difference: (i) The highest of all other bids $Y \in (v - \epsilon, v)$ and it comes either from another standard bidder or from the unreliable bidder who then does not default. Bidding v will win the auction, but biding $v - \epsilon$ will not. (ii) The highest of all other bids $Y \in (v - \epsilon, v)$ and it comes from the unreliable bidder who then defaults. Bidding v will win the auction, but bidding $v - \epsilon$, would make me the runner-up so that I pay only the third highest bid $\bar{Y}$. (iii) The unreliable bidder places the highest bid, with $Y > v$, and defaults, whereas the highest bid from the other standard bidders $\bar{Y} \in (v - \epsilon, v)$. Bidding v will make me the runner-up who gets the second-chance offer after the unreliable bidder defaults, but bidding $v - \epsilon$ will not.

Case (i) occurs with a probability of the order of ϵ. Bidding v, I get a payoff of $v - Y$, which is about $\epsilon/2$ in expectation (because for ϵ small, the distribution of the highest bid between $v - \epsilon$ and v is close to uniform). Case (ii) occurs with a probability of the order of $\delta\epsilon$. Conditional on the case occurring, bidding v yields an expected payoff of about $\epsilon/2$ (as above). Bidding $v - \epsilon$, yields a payoff of $v - \bar{Y}$. Case (iii) occurs with a probability of the order of $\delta\epsilon$. Conditional on the case occurring, bidding v yields an expected payoff of about $\epsilon/2$, because the price is then $\bar{Y} \in (v - \epsilon, v)$.

Summing up, bidding v instead of $v - \epsilon$ provides a gain in expected payoff in cases (i) and (iii) which is of the order of ϵ^2 and bounded above by $C\,\epsilon^2$, for some constant $C > 0$. Bidding v instead of $v - \epsilon$ provides a loss in expected payoff in case (ii) which is of the order of $\delta\epsilon(v - \bar{Y})$ and bounded below by $c\,\delta\epsilon(v - \bar{Y})$, for some constant $c > 0$. Given that δ and $v - \bar{Y}$ are independent of ϵ, $C\,\epsilon^2 < c\,\delta\epsilon(v - \bar{Y})$ for ϵ sufficiently small. Thus, for ϵ sufficiently small, the expected payoff of bidding $v - \epsilon$ is larger than the expected payoff of bidding v. Therefore, a third-price rule after default does not solve the problem of underbidding of standard bidders.

A.2 The second-chance offer mechanism as a commitment device

The fact that auction sites such as eBay restrict second-chance offers to equal the runner-up's bid may in fact be a good commitment device for the seller. It makes a difference, whether there is commitment by the seller to charge the runner-up's own bid, or if the second-chance offer can be any outcome of a "negotiation". Even with bid shading, bids fully reveal the standard bidders' values in a pure-strategy equilibrium. Thus a seller who has complete bargaining power could make a take-it-or-leave-it offer to the runner-up at his value. In such a setting, without commitment, the equilibrium involves some pooling of bids so that bidders do not reveal their values completely (see, e.g. Krishna, 2009, p.54-57). This then causes inefficiencies that lower the revenue for the seller.

B Proofs

B.1 Proof of Proposition 1

We prove the result in several steps. Result (i) follows from steps 1-5, (ii) from step 6, and (iii) and (iv) from step 7.

1. Standard bidders' bids cannot be zero for all non-zero values in equilibrium. By way of contradiction, suppose all standard bidders $i = 2, \dots, N-1$ bid zero. Then if bidder 1 has $v_1 > 0$ and bids an amount $\epsilon > 0$, he beats all standard bidders for sure and wins for sure if there is a default. For sufficiently small ϵ, the gain from a discrete jump in winning probability dominates the cost from having to pay ϵ after default rather than zero.[19] This contradicts that $\beta(v_i) = 0$ for all v_i in a symmetric equilibrium.

[19] Essentially, when all the other standard bidders bid 0 for all values, by bidding marginally above 0, bidder 1 is in a two-person continuation game against the default bidder. For low default probability δ it is optimal for him to bid close to value, for high δ he should bid close to, but strictly above zero (to beat the other standard

2. By standard arguments, β must be strictly increasing. By way of contradiction, suppose $\beta(v') = \beta(v'') = b$ for some $v'' > v'$. Then for a bidder with $v_i \in [v', v'']$ there is a probability $\epsilon \geq F(v'') - F(v') > 0$ of a tie with another standard bidder, for winning outright or for winning after a default. At least a bidder with value v'' strictly prefers winning at price b. Increasing the bid by an infinitesimal amount would make him win for sure if such a tie occurred. As above, the discrete gain with probability ϵ dominates the infinitesimal cost in cases where there is no tie. This yields a contradiction. This implies that in a symmetric equilibrium standard bidders' bid are positive for all non-zero values.

3. Suppose all standard bidders $i = 2, \ldots, N-1$ bid according to $\beta(v_i)$ and the unreliable bidder N bids is value. Denote by $G(y)$ the distribution of the highest bid from these bidders $i \neq 1$. Then the payoff of standard bidder 1, who has value v and bids b, is:

$$\begin{aligned} \Pi_1(b, v) &= \int_0^b (v - y)\, dG(y) \\ &\quad + \delta\, Prob(b > \max\{\beta(v_2), \ldots, \beta(v_{n-1})\})\, [1 - F(b)]\, (v - b) \end{aligned} \tag{1}$$

The first part captures that if bidder 1 is the highest bidder, he pays the second highest bid. The second part reflects that if bidder 1 is the runner-up to the unreliable bidder, he pays his own bid in case the unreliable bidder defaults.

4. We now establish that the payoff function (1) is continuous.[20] Fix $b \geq 0$ for bidder 1 and a strictly increasing bid function for the other standard bidders β. Consider a sequence $b^k \to b$ such that $lim_{k\to\infty}\Pi_1(b^k, v) \equiv L$ exists. Assume first that $b^k \uparrow b$. Note that the indicator functions of events $[b^k > \max\{\beta(v_2), \ldots, \beta(v_{n-1})\}]$ converge pointwise to the indicator function of $[b > \max\{\beta(v_2), \ldots, \beta(v_{n-1})\}]$. Because bids are bounded by v, so is the convergent sequence $\{b^k\}$. By the Dominated Convergence Theorem (e.g., Billingsley, 1995, p. 209), the limit from below $L_- \leq \Pi_1(b, v)$. The inequality is strict only if $Prob(b^k = \max\{\beta(v_2), \ldots, \beta(v_{n-1})\}) > 0$, which however is not the case because bid functions are strictly increasing (by step 2). Next assume that $b^k \downarrow b$. Now the indicator functions of events $[b^k > \max\{\beta(v_2), \ldots, \beta(v_{n-1})\}]$ converge pointwise to the indicator function of $[b \geq \max\{\beta(v_2), \ldots, \beta(v_{n-1})\}]$. So the limit from above $L_+ \leq \Pi_1(b, v)$. Because bid functions are strictly increasing (by step 2), $Prob(b^k = \max\{\beta(v_2), \ldots, \beta(v_{n-1})\}) = 0$. Therefore, $L = L_+ = L_-$.

bidders). See also the example of a two-person auction in the main text.

[20]This step follows closely the proof of Lemma 14 in Battigalli and Siniscalchi (2003).

For the standard bidder 1, consider an arbitrary convergent sequence $b^k \to b$ and an arbitrary subsequence $\{b^{k_n}\}$ for which $\lim_{n\to\infty} \Pi_1(b^{k_n}, v) \equiv M$ exists. If the subsequence is itself monotonic, then we can apply our previous arguments to conclude that $M \leq \Pi_1(b, v)$. If not, then the subsequence must contain a monotonic sub-subsequence $\{b^{k_{nm}}\}$ such that $b^{k_{nm}} \to v$ and $\Pi_1(b, v) \geq \lim_{m\to\infty} \Pi_1(b^{k_{nm}}, v) = M$.

5. Differentiating (1) yields

$$\begin{aligned} \frac{d}{d\,b}\,\Pi_1(b,v) &= (v-b)\,g(b) + \delta\,\frac{d}{d\,b}\,Prob(b > \max\{\beta(v_2),\ldots,\beta(v_{n-1})\})\,\cdot\,(1-F(b))\,(v-b) \\ &- \delta\,Prob(b > \max\{\beta(v_2),\ldots,\beta(v_{n-1})\})\,[f(b)\,(v-b) + 1 - F(b)]\,. \end{aligned} \tag{2}$$

Note that because bid functions are strictly increasing and *onto* functions, G has no atoms and admits a density function g. Evaluating (2) at $b = v$, we get

$$\left.\frac{d}{d\,b}\,\Pi_1(b,v)\right|_{b=v} = -\delta\,Prob(v > \max\{\beta(v_2),\ldots,\beta(v_{n-1})\})\,[1-F(v)] < 0 \text{ for } 0 < v < 1 \text{ and } \delta > 0.$$

Hence, the standard bidders bid less than their value for $v \in (0, 1)$.[21]

6. Note that $Prob(\beta(z) > \max\{\beta(v_2),\ldots,\beta(v_{n-1})\}) = F(z)^{N-2}$ and $G(\beta(y)) = F(\beta(y))F^{N-2}(y)$, with

$$\frac{d}{d\,y}G(\beta(y)) = f(\beta(y))\beta'(y)F^{N-2}(y) + (N-2)F(\beta(y))F^{N-3}(y)f(y). \tag{3}$$

Hence, the maximization problem of a standard bidder is given by

$$\max_{z\in[0,1]} \int_0^z (v-\beta(y))\,dG(\beta(y)) + \delta\,F(z)^{N-2}\,[1-F(\beta(z))]\,(v-\beta(z)) \tag{4}$$

The first order condition,

$$\begin{aligned} &(v-\beta(z))\,(N-2)\,F^{N-3}(z)f(z)\,\,[F(\beta(z))(1-\delta)+\delta] \\ &+F^{N-2}(z)\,\,[(v-\beta(z))f(\beta(z))(1-\delta) - \delta(1-F(\beta(z)))]\,\beta'(z) = 0, \end{aligned} \tag{5}$$

holds at $z = v$ in equilibrium. The resulting differential equation together with the boundary condition $\beta(0) = 0$ defines the equilibrium bidding function implicitly:

$$\beta'(v) = \frac{(v-\beta(v))\,(N-2)\,\frac{f(v)}{F(v)}\,\,[F(\beta(v))(1-\delta)+\delta]}{\delta\frac{(1-F(\beta(v)))}{f(\beta(v))} - (v-\beta(v))(1-\delta)} \tag{6}$$

[21] One can easily see that the basic insights about bid shading readily extend if all bidders may default with a probability δ. Denoting by $H(y)$ the distribution of the second highest bid among bidders $i \neq 1$, the payoff of bidder 1 is $\Pi_1(b,v) = \int_0^b (v-y)\,dG(y) + \delta\,H(b)\,[1-G(b)]\,(v-b)$. Again, for $b \to v$, the derivative with respect to b is negative because the $v-b$ terms vanish.

By the Picard-Lindelöf theorem (e.g. Coddington and Levinson, 1955, p.12), any solution that satisfies the Lipschitz condition is unique. Using the mononotone hazard rate property of F, this is the case for any $b > \bar{b}$, where $\bar{b}$ is defined by

$$\delta \frac{1 - F(\bar{b})}{f(\bar{b})} = (v - \bar{b})(1 - \delta). \tag{7}$$

Suppose a solution $\beta(v) \leq \bar{b}$ existed. Then to satisfy first order condition (5), either $\beta(v) = v$ or $\beta'(v) < 0$, which contradicts (i).

7. Consider the boundary cases $\delta = 0$ and $\delta = 1$. If $\delta = 0$, the bidder's payoff in (1) is just as in a standard N-player second-price auction. If $\delta = 1$, we are considering the symmetric equilibrium of an $N-1$-bidder *standard auction* as defined in Krishna (2010, p.27): bid functions are strictly increasing and a zero value bidder has zero payoff. Specifically, though the unreliable bidder always defaults, his bid influences the price paid by the $N-1$ bidders in the auction. The auction hence is a standard auction with a random price assignment rule. For example, if bidder 1 places the winning bid b, then $price = b$ with $Prob(v_N > b \geq \max\{\beta(v_2), \ldots, \beta(v_{n-1})\})$, $price = v_N$ with $Prob(b > v_N \geq \max\{\beta(v_2), \ldots, \beta(v_{n-1})\})$, and $price = \max\{\beta(v_2), \ldots, \beta(v_{n-1})\}$ with $Prob(b > \max\{\beta(v_2), \ldots, \beta(v_{n-1})\} > v_N)$. The symmetric equilibrium of the auction hence is revenue equivalent with the $N-1$-bidder first-price, sealed-bid auction auction (cf. Krishna 2010, Proposition 3.1).

   Moreover, payment equivalence implies that *for each value* the expected payment of a bidder is the same across auctions (cf. Krishna 2010, Equation (3.2) in the proof of Proposition 3.1). With strictly positive probability the winning bidder does not pay his own bid but only the second highest bid. Thus, the expected payment can only be equal to that in the $N-1$-bidder first-price, sealed-bid auction auction if bids are strictly higher *for each value* $v > 0$. That is, bids do not converge to the first-price auction bids.

B.2 Proof of Proposition 2

For $\delta = 0$, bids and, hence, revenue are as in the symmetric equilibrium of a standard N-bidder second-price auction (Proposition 1). Next, we show that bid function of the standard bidders $\beta(v_i)$ is strictly decreasing in δ for $v_i \in (0, 1)$. Because β is strictly increasing in v_i it admits a strictly increasing inverse bid function ϕ. So $Prob(b > \max\{\beta(v_2), \ldots, \beta(v_{n-1})\}) =$

$F(\phi(b))^{N-2}$, allowing to rewrite (2)

$$\frac{d}{d\,b}\,\Pi_1(b,v) = (v-b)\,g(b)$$
$$+\delta\,\underbrace{\left[(N-2)F(\phi(b))^{N-3}\,f(\phi(b))\,\phi'(b)\,[1-F(b)]\,(v-b) - F(\phi(b))^{N-2}\,(f(b)\,(v-b)+1-F(b))\right]}_{=:\Psi(b)}.$$

We know that $v > \beta(v) > 0$ for $1 > v > 0$, ruling out a corner solution. In equilibrium, the bids $b = \beta(v)$ hence satisfy the following first-order condition

$$(v-b)\,g(b) + \delta\,\Psi(b) = 0. \tag{8}$$

That is, $\Psi(b) < 0$. The second-order conditions imply that $(v-b)\,g'(b) - g(b) + \delta\,\Psi'(b) < 0$. Hence, if we hold the other bidders' strategies fixed, the left-hand-side of (8) decreases in δ. Further, note that the second-order conditions imply that the left-hand-side of (8) is still decreasing in b after a marginal change in δ. Thus, a marginal increase in δ leads to a lower best response of bidder 1. As this holds for all standard bidders, equilibrium bids in a regular equilibrium have to be lower (the best response functions are shifted downwards).

This immediately implies that the seller's expected revenue is decreasing in δ. Independent of whether default occurs or not, the price paid is always equal to the second highest bid by the N original bidders. Bids of the unreliable bidder are not affected by δ but those of the standard bidders are strictly decreasing in δ. Hence, expected revenue is also strictly decreasing in δ.

B.3 Proof of Proposition 3

For $\delta = 1$, the auction is revenue equivalent to the symmetric equilibrium of the standard $(N-1)$-bidder second-price (see the proof of Proposition 1). Because expected revenue is strictly decreasing in δ (Proposition 2), for any $\delta \in [0,1)$ expected revenue hence is strictly higher than in the $(N-1)$-bidder second-price auction. Excluding the unreliable bidder turns the auction into a standard $(N-1)$-bidder second-price auction and therefore strictly lowers expected revenue compared to not excluding the unreliable bidder for delta in $[0,1)$.

B.4 Proof of Proposition 4

(i) Recall that bidders' equilibrium payoff with $\delta = 0$ is the same as in the symmetric equilibrium of the standard second-price auction. For $\delta > 0$, a standard bidder can always guarantee himself at least the same payoff as in the symmetric equilibrium of the standard second-price auction by bidding his value, because none of the other bidders bids higher than their value. In fact, the standard bidder has a strictly higher payoff because, in equilibrium, the other standard bidders bid *less* than their value.

(ii) Let β_δ denote the standard bidders' equilibrium strategy if the unreliable bidder has default probability δ. Now consider an increase in the default probability from δ_1 to $\delta_2 > \delta_1$. Suppose standard bidders all continue to bid according to β_{δ_1}, then their expected payoff increases because there is a higher chance that the unreliable bidder defaults and a standard bidder gets $v - \beta_{\delta_1}$. Further, even if a standard bidder continued to bid β_{δ_1}, while all others choose the equilibrium strategy β_{δ_2}, he would be better off than if all bid β_{δ_1}, because standard bidders' equilibrium bids are decreasing in δ (see the proof of Proposition 2) and this lowers the expected price conditional on winning the auction outright. Finally, the bidder will at least be as well off with his equilibrium bid β_{δ_2} than bidding β_{δ_1}.

(iii) This follows directly from the fact that standard bidders bid strictly less than their value when they bid against an unreliable bidder (Proposition 1).

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Online Appendix

Second-Chance Offers and Buyer Reputation:

Theory and Evidence on Auctions with Default.

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A Examples of second-chance-offer rules in online auctions

eBay.com (*one of the leading online auction sites used by consumers and businesses*). A seller who does not receive payment for an item sold can open an unpaid item case. If the winning bidder still does not send payment, the seller can make a "Second Chance Offer" to any remaining bidder or relist the item and get credited for the fees of the failed auction.[1] A "Second Chance Offer" is a take-it-or-leave it option to buy the item at a "Buy It Now price" equal to his or her maximum amount bid. The offer expires after a duration chosen by the seller.[2]

Yahoo!Auctions Japan (*one of the leading online auction sites in Japan*) In case of non-payment, the seller can "delete" the winning bidder and offer the item to the runner-up bidder, who can accept to pay his or her last bid or reject. A non-paying bidder who is deleted automatically receives negative feedback for the transaction. It comes with the special label "very poor" attached so that it stands out in the feedback history.[3]

AssetLine.com (*a world leading online construction equipment exchange*). If the winning bidder fails to complete the transaction, the second highest bidder is declared the new winning bidder and has to accept or decline the sale immediately.[4]

Cunningham & Associates, Inc (*a leading bankruptcy and industrial auction company in Arizona*). If the winning bidder fails to complete the sale, the second highest bidder is given the option to buy at his or her last bid.[5]

Bid4Assets.com (*a U.S. online real estate auction site*). If the winning bidder does not contact the seller to confirm the sale within two business days or fails to complete payment within five days (30 days for real estate), the seller has the option to offer the item to the second highest bidder.[6]

csassets.com (*an online auction site specializing in the sale of bankruptcy assets and personal assets*). If the winning bidder fails to complete the sale within 14 days, the seller has the option to offer the item to the second highest bidder.[7]

[1] `http://pages.ebay.com/help/sell/unpaid-items.html`, accessed February 2020.
[2] `http://pages.ebay.com/help/sell/second_chance_offer.html`, accessed February 2020.
[3] `https://auctions.yahoo.co.jp/guide/guide/qa.html`, machine translated and accessed February 2020
[4] `http://www.assetline.com/webauc/jsp/1/base/tnc_en.html`, accessed February 2020.
[5] `https://www.cunninghamauctions.com/terms-and-conditions`, accessed February 2020.
[6] `http://www.bid4assets.com/Help/index.cfm?fuseAction=sellerAfter`, accessed February 2020.
[7] `http://csassets.com/terms-and-conditions/`, accessed February 2020.

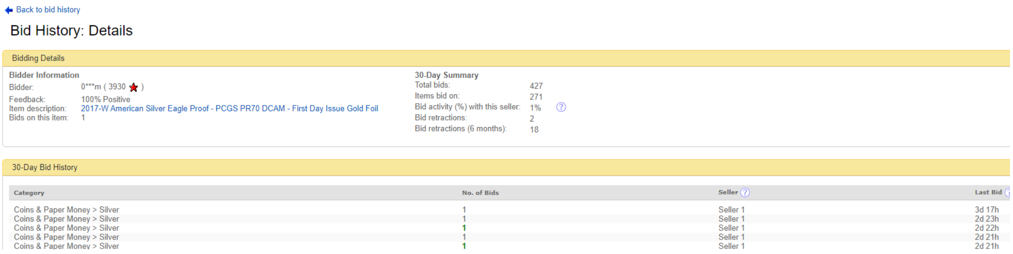


Figure A.1: Bid retractions are publicly visible from a bidder's profile page

B Examples of buyer reputation systems

A typical design implemented by eBay and Yahoo!auctions, among others, is that traders can leave a positive, neutral, or negative rating in addition to a brief verbal comment. Positive ratings add, negative ratings subtract from the user's aggregate feedback score, while neutral ratings have no numerical impact on the aggregate feedback score. In a bilateral reputation system, participants in auctions have quick access to the aggregate feedback score of the seller and of other bidders. A few clicks often will show participants' detailed transaction history and comments. On Yahoo!Auctions Japan, a user's feedback score aggregates buy and sell transactions, eBay moved from a system of separate buyer and seller reputations to one where only one reputation score is displayed. But all users still can see whether a bidder in an auction has a history of withdrawing bids.

eBay.com. Buyers can assign sellers a negative, neutral, or positive rating. Sellers can only leave buyers positive feedback, increasing the buyer's feedback score by one, or choose not to leave any.[8] In each auction, one can open a list of bids and the feedback score of each bidder is displayed next to their bid and visible to all potential buyers, who can with a click see the bidder's bid history.[9] A summary tab shows the total number of bids, how many times the user retracted a bid in the last 30 days and the last 6 months. The rate of bid retractions gives a good sense of how reliable a buyer is (see Figure A.1). From 2001 until 2008, users had separate feedback scores for buyer and seller transactions, which helped people distinguish the context in which a member had received feedback. For more details on the history of eBay's reputation system see, for example, Li (2010).

Yahoo!Auctions Japan. In addition to assigning a negative (-1), neutral, or positive (+1) score, comments allow to distinguish between "bad" and "very poor" or "good" and "very

[8] http://pages.ebay.com/help/feedback/howitworks.html, accessed February 2020.

[9] https://www.ebay.com/help/account/changing-account-settings/feedback-profiles?id=4204, accessed February 2020.

good" performance. The aggregated feedback score sums up the positive and negative scores from all transactions with new trading partners. If one deals with the same trading partner again, only the last rating counts and the number of ratings does not increase. One can look up ratings for a particular trading partner on the ratings page of a user. These ratings are publicly displayed under a user's profile, with links to the specific auctions for which a rating was given. In auctions, users who are logged in can see information about the feedback scores of other bidders.[10]

Tabao (*the world's largest online consumer-to-consumer e-commerce platform, including online auctions*). Similar to eBay, buyers and sellers can leave each other positive, neutral, or negative feedback, and in addition comments about the transaction. There are two differences, though. Taobao separately reports the rating score for a user as a seller and as a buyer instead of aggregating it into one score as eBay does since 2008. Whenever a seller leaves positive feedback for a buyer, the platform automatically records positive feedback for the seller if the buyer does not respond. For more details see, e.g., Li et al. (2016).

C Auctions with discrete values used for the experiments

The setup is the same as in the model with continuous values presented in the paper. There is an unreliable bidder, who is known to default with probability $\delta \in (0,1)$ if he wins the auction. The remaining bidders are standard bidders who never default. The highest bidder wins the auction and pays the second highest bid as the price. If the default bidder wins and then defaults, he gains a payoff of zero and the runner up receives (and has to accept)[11] a second-chance offer at his own bid price (which is equal to the original price the winner would have had to pay). Ties are resolved by random allocation with an equal chance for each bidder in the tie. We consider the case with values v uniformly distributed over $\{0,2,4\}$. Allowed bids are the integer values $b \in \{0,1,2,3,4,5\}$. As in the paper, we restrict attention to equilibria where the unreliable bidder plays the weakly dominant strategy of bidding his own value (regular equilibria).

[10] `https://www.yahoo-help.jp/app/answers/detail/p/353/a_id/40710`, machine translated and accessed February 2020

[11] In the experiments we excluded the possibility of rejecting a second-chance offer to simplify the design and make it easier to explain. For the theoretical predictions it makes no difference whether the second-chance offer can be rejected or not. A rejection will only happen if a standard bidder overbids, which anyway is a (weakly) dominated strategy when the unreliable bidder bids his own value.

C.1 Two-bidder auctions

Proposition A.1 *There exists a pure-strategy Nash equilibrium where the unreliable bidder bids his own value and the standard bidder bids according to $\beta(v)$, which together with expected revenue is given by*

Default probability δ	$\beta(0)$	$\beta(2)$	$\beta(4)$	*Expected revenue*
$0 < \delta \leq 1/3$	*0*	*1*	*3*	*7/9*
$1/3 \leq \delta \leq 2/5$	*0*	*0*	*3*	*5/9*
$2/5 \leq \delta \leq 1/2$	*0*	*0*	*1*	*2/9*
$1/2 \leq \delta \leq 1$	*0*	*0*	*0*	*0*

For comparison, in the standard second-price, sealed-bid auction with pure-strategy equilibrium $\beta(v) = v$ the expected revenue is 10/9.

Proof.
Let $P(b)$ denote the probability of the standard bidder bidding b and $N(b)$ denote the probability of the unreliable bidder bidding b under a candidate equilibrium strategy.

Step 1: Best response of the unreliable bidder. As is straightforward to check, the unique best response of an unreliable bidder with value zero is to bid zero provided $P(0) < 1$. If $P(0) = 1$, bidding zero remains a (weak) best response, as any admissible bid is a best response.
It is a (weak) best response for an unreliable bidder with value two to bid two. We establish this by calculation of the expected payoff $\pi_{unrel.}(b|v)$ of an unreliable bidder with value $v = 2$ for any admissible bid:

$$
\begin{aligned}
E[\pi_{unrel.}(0|2)] &= (1-\delta)\left[P(0)\,\frac{1}{2}\,2\right] \\
E[\pi_{unrel.}(1|2)] &= (1-\delta)\left[P(0)\,2 + P(1)\,\frac{1}{2}\right] \\
E[\pi_{unrel.}(2|2)] &= (1-\delta)\left[P(0)\,2 + P(1)\,1 + P(2)\,\frac{1}{2}\,0\right] \\
E[\pi_{unrel.}(3|2)] &= (1-\delta)\left[P(0)\,2 + P(1)\,1 + P(2)\,0 + P(3)\,\frac{1}{2}\,(-1)\right] \\
E[\pi_{unrel.}(4|2)] &= (1-\delta)\left[P(0)\,2 + P(1)\,1 + P(2)\,0 + P(3)\,(-1) + P(4)\,\frac{1}{2}\,(-2)\right] \\
E[\pi_{unrel.}(5|2)] &= (1-\delta)\left[P(0)\,2 + P(1)\,1 + P(2)\,0 + P(3)\,(-1) + P(4)\,(-2) + P(5)\,\frac{1}{2}\,(-3)\right].
\end{aligned}
$$

It is a (weak) best response for an unreliable bidder with value four to bid four:

$$\begin{aligned}
E[\pi_{unrel.}(0|4)] &= (1-\delta)\left[P(0)\,\frac{1}{2}\,4\right] \\
E[\pi_{unrel.}(1|4)] &= (1-\delta)\left[P(0)\,4 + P(1)\,\frac{1}{2}\,3\right] \\
E[\pi_{unrel.}(2|4)] &= (1-\delta)\left[P(0)\,4 + P(1)\,3 + P(2)\,\frac{1}{2}\,2\right] \\
E[\pi_{unrel.}(3|4)] &= (1-\delta)\left[P(0)\,4 + P(1)\,3 + P(2)\,2 + P(3)\,\frac{1}{2}\,1\right] \\
E[\pi_{unrel.}(4|4)] &= (1-\delta)\left[P(0)\,4 + P(1)\,3 + P(2)\,2 + P(3)\,1 + P(4)\,\frac{1}{2}\,0\right] \\
E[\pi_{unrel.}(5|4)] &= (1-\delta)\left[P(0)\,4 + P(1)\,3 + P(2)\,2 + P(3)\,1 + P(4)\,0 + P(5)\,\frac{1}{2}\,(-1)\right].
\end{aligned}$$

Step 2: Best response of the standard bidder. Again, it is straightforward that the unique best response of a standard bidder with value zero is to bid zero provided $N(0) < 1$. If $N(0) = 1$, bidding zero remains a (weak) best response. The expected payoff $\pi_{stand.}(b|v)$ of a standard bidder with value $v = 2$ for any admissible bid is:

$$\begin{aligned}
E[\pi_{stand.}(0|2)] &= N(0)\,\frac{1}{2}\,2 + 2\cdot\delta\left[N(0)\,\frac{1}{2} + N(1) + N(2) + \cdots + N(5)\right] \\
E[\pi_{stand.}(1|2)] &= N(0)\,2 + N(1)\,\frac{1}{2}\,1 + 1\cdot\delta\left[N(1)\,\frac{1}{2} + N(2) + \cdots + N(5)\right] \\
E[\pi_{stand.}(2|2)] &= N(0)\,2 + N(1)\,1 + N(2)\,\frac{1}{2}\,0 + 0\cdot\delta\left[N(2)\,\frac{1}{2} + N(3) + \cdots + N(5)\right] \\
E[\pi_{stand.}(3|2)] &= N(0)\,2 + N(1)\,1 + N(2)\,0 + N(3)\,\frac{1}{2}\,(-1) + (-1)\cdot\delta\left[N(3)\,\frac{1}{2} + N(4) + N(5)\right] \\
E[\pi_{stand.}(4|2)] &= N(0)\,2 + N(1)\,1 + N(2)\,0 + N(3)\,(-1) + N(4)\,\frac{1}{2}\,(-2) + (-2)\cdot\delta\left[N(4)\,\frac{1}{2} + N(5)\right] \\
E[\pi_{stand.}(5|2)] &= N(0)\,2 + N(1)\,1 + N(2)\,0 + N(3)\,(-1) + N(4)\,(-2) + N(5)\,\frac{1}{2}\,(-3) + (-3)\cdot\delta\left[N(5)\,\frac{1}{2}\right].
\end{aligned}$$

Clearly, bidding above two is weakly dominated by bidding two, and bidding two is strictly dominated by bidding one if the unreliable bidder bids his own value (i.e. $N(1) = 0$ and $N(0) = N(2) = N(4) = 1/3$) because

$$E[\pi_{stand.}(2|2)] - E[\pi_{stand.}(1|2)] = \left[1 - \frac{1}{2}(1+\delta)\right] N(1) - \delta\,[N(2) + \cdots + N(5)]$$

then becomes $-(2/3)\,\delta$. Comparing the expected payoff from bids 0 and 1 then yields optimal bids of one ($\delta \leq 1/3$) or zero ($\delta \geq 1/3$):

$$\begin{aligned}
&E[\pi_{stand.}(1|2)] - E[\pi_{stand.}(0|2)] = 2\left[1 - \frac{1}{2}(1+\delta)\right] N(0) + \left[\frac{1}{2} - 2\,\delta\right] N(1) - \delta\,[N(3) + \cdots + N(5)] \\
&= \frac{1}{3} - \delta \quad \text{if the unreliable bidder bids his value (i.e. } N(0) = N(2) = N(4) = 1/3).
\end{aligned}$$

The expected payoff $\pi_{stand.}(b|v)$ of a standard bidder with value $v = 4$ for any admissible bid is:

$$
\begin{aligned}
E[\pi_{stand.}(0|4)] &= N(0)\,\frac{1}{2}\,4 + 4\cdot\delta\,\left[N(0)\,\frac{1}{2} + N(1) + N(2) + \cdots + N(5)\right] \\
E[\pi_{stand.}(1|4)] &= N(0)\,4 + N(1)\,\frac{1}{2}\,3 + 3\cdot\delta\,\left[N(1)\,\frac{1}{2} + N(2) + \cdots + N(5)\right] \\
E[\pi_{stand.}(2|4)] &= N(0)\,4 + N(1)\,3 + N(2)\,\frac{1}{2}\,2 + 2\cdot\delta\,\left[N(2)\,\frac{1}{2} + N(3) + \cdots + N(5)\right] \\
E[\pi_{stand.}(3|4)] &= N(0)\,4 + N(1)\,3 + N(2)\,2 + N(3)\,\frac{1}{2}\,1 + 1\cdot\delta\,\left[N(3)\,\frac{1}{2} + N(4) + N(5)\right] \\
E[\pi_{stand.}(4|4)] &= N(0)\,4 + N(1)\,3 + N(2)\,2 + N(3)\,1 + N(4)\,\frac{1}{2}\,0 + 0\cdot\delta\,\left[N(4)\,\frac{1}{2} + N(5)\right] \\
E[\pi_{stand.}(5|4)] &= N(0)\,4 + N(1)\,3 + N(2)\,2 + N(3)\,1 + N(4)\,0 + N(5)\,\frac{1}{2}\,(-1) + (-1)\cdot\delta\,\left[N(5)\,\frac{1}{2}\right].
\end{aligned}
$$

Again, bidding above the own value is (weakly) dominated by bidding v. If the unreliable bidder bids his value, bidding v is strictly dominated by bidding three (because $N(3) = 0$). Plugging in $N(0) = N(2) = N(4) = 1/3$, we obtain

$$
\begin{aligned}
E[\pi_{stand.}(0|4)] &= \frac{2}{3} + \frac{10}{3}\,\delta & \qquad E[\pi_{stand.}(1|4)] &= \frac{4}{3} + 2\,\delta \\
E[\pi_{stand.}(2|4)] &= \frac{5}{3} + \delta & \qquad E[\pi_{stand.}(3|4)] &= 2 + \frac{1}{3}\,\delta.
\end{aligned}
$$

Comparing the expected payoff from bids 0, 1, 2, and 3 (see Figure A.2) then yields optimal bids of three ($\delta \leq 2/5$), one ($2/5 \leq \delta \leq 1/2$), or zero ($\delta \geq 1/2$).

The derivation of expected revenues is straightforward and omitted.

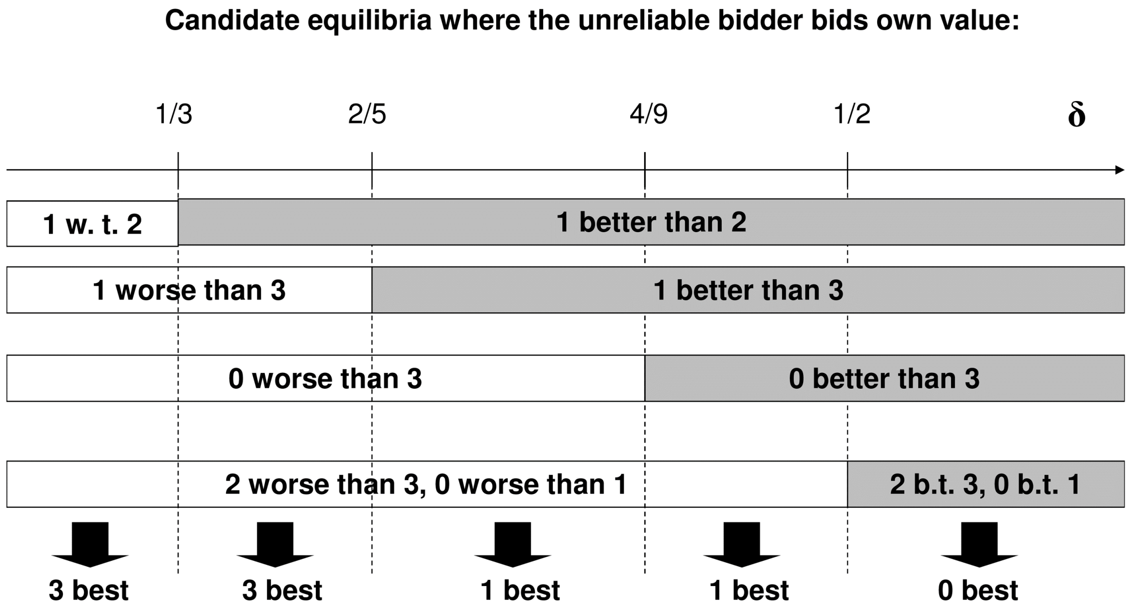


Figure A.2: Best response of the standard bidder with value $v = 4$

■

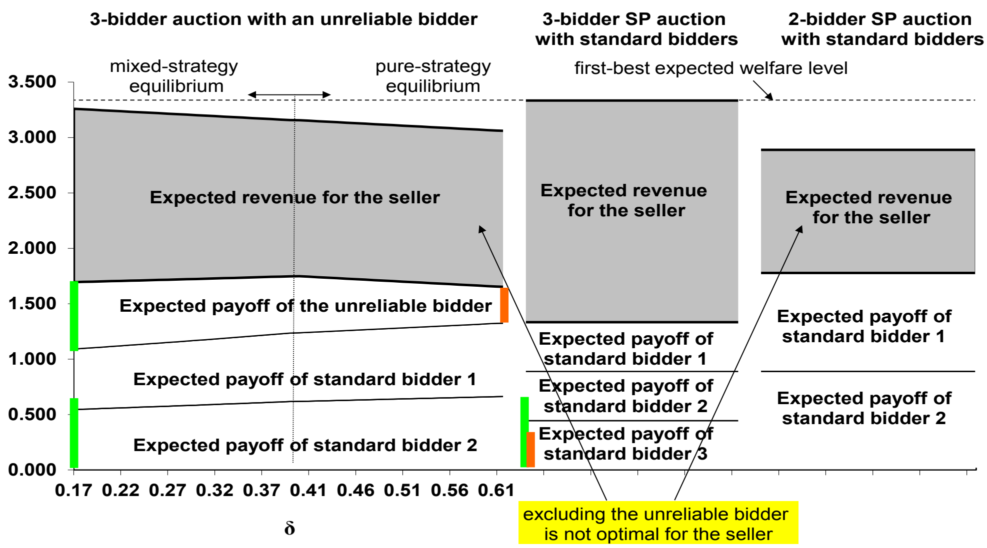
C.2 Three-bidder auctions

As in the paper, we look for a Nash equilibrium where the unreliable bidder bids his own value and the standard bidders have a symmetric strategy (regular equilibrium). That is, both bid according to same bid function $\beta(v)$ or follow the same mixed strategy placing probability $P(b|v)$ on bid b if the value is v. To simplify exposition, we restrict attention to the ranges for the default parameter δ that are relevant for the experiment, where $\delta = 0$, 1/6, 1/2, and 3/5 were implemented.

Proposition A.2 *There exists a pure-strategy Nash equilibrium where the unreliable bidder bids his own value and the two standard bidders bid according to the following strategy:*

valuation	*Default probability* δ	
	$\delta \in [1/6, 2/5)$	$\delta \in [2/5, 8/13]$
$v = 0$	$\beta(0) = 0$	
$v = 2$	$\beta(2) = 1$	
$v = 4$	$\begin{cases} P(3\|4) = p = \frac{4\,\delta}{2-\delta} \\ P(4\|4) = 1 - p \end{cases}$	$\beta(4) = 3$

Proof available upon request. Figure A.3 provides an illustration of buyer payoffs and seller revenues in comparison to a standard second-price, sealed-bid auction with pure-strategy equilibrium $\beta(v) = v$.



Note: To facilitate comparison of payoffs between the Unreliable and standard bidders, the green (orange) bar indicates the expected payoff of the unreliable bidder at the lowest (highest) default probability.

Figure A.3: Outcomes in three-bidder auctions

D Additional results for two-player experiments

D.1 Comparative statics for a given bidder type.

Table A.1 provides additional specifications on the within-bidder comparisons from Table 3 in the paper (which reported fixed-effects regressions restated here as specifications (3) and (7)). The findings reported in the paper are all robust. In particular, there is a robust pattern of the standard bidders reducing their bids when the default probability is $\delta = 0.6$.

Table A.3 reports results from ordered logit regressions for each value the bidder may have. For the unreliable bidders, there is a tendency to increase bids on value four when the default probability increases from 0.25 to 0.6 in the periods 51-100 (possibly reflecting frustration from not winning on account of frequent default), and to decrease bids on values zero and two when the default probability decreases from 0.25 to 0.1 in the periods 51-100 (possibly reflecting learning not to overbid, in particular on value zero). Consistent with the previous results, for the standard bidders we find a robust pattern of the high default probability 0.6 leading to a reduction in bids on all values.

D.2 Comparison across bidder types and with bidding in the standard second-price auction.

Table A.2 re-estimates the specifications from Table 3 in the paper (which are restated here as specifications (1), (2), (5), and (7)) using tobit regressions that account for the fact that bids are restricted to the interval $[0, 5]$. The findings reported in the paper are all robust.

Consistent with the previous results, the ordered logit regressions in Table A.3 reveal a robust pattern where the high default probability 0.6 leads standard bidders to bid less compared to unreliable bidders and to bidding in a standard second-price auction. Again, we find little impact on bidding of the lower default probabilities 0.1 and 0.25.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	UvsU[a]	UvsU	UvsU	UvsU	SvsS[a]	SvsS	SvsS	SvsS
	OLS	Tobit	FE[b]	RE[b]	OLS	Tobit	FE[b]	RE[b]
$\delta = 0.1$	-0.166	-0.177	-0.130	-0.131	0.024	0.020	-0.149	-0.146
	(0.12)	(0.13)	(0.10)	(0.10)	(0.18)	(0.19)	(0.22)	(0.12)
$\delta = 0.25$				omitted category				
$\delta = 0.6$	0.177*	0.186*	0.142**	0.143***	-1.130***	-1.242***	-0.957***	-0.961***
	(0.09)	(0.11)	(0.05)	(0.05)	(0.22)	(0.25)	(0.26)	(0.22)
Constant	3.760***	3.815***	3.760***	3.760***	3.523***	3.559***	3.523***	3.523***
	(0.07)	(0.09)	(0.13)	(0.07)	(0.11)	(0.12)	(0.12)	(0.11)
N	4800	4800	4800	4800	4800	4800	4800	4800
Generalized Hausman test, H0: overidentifying restrictions of random effects model satisfied								
Sargan-Hansen statistic				0.234				2.788
p-value				0.628				0.095

Notes: Robust standard errors in parentheses (clustered at matching group level).

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. [a] U: unreliable bidder, S: standard bidder.

[b] FE: bidder fixed effects model, RE: random effects model.

Table A.1: Regressions for average bids on values 2 and 4 (within-bidder comparisons)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	UvsS[a]	UvsS	UvsS	UvsS	SPvsU[a]	SPvsU	SPvsS	SPvsS
	OLS	OLS	Tobit	Tobit	OLS	Tobit	OLS	Tobit
$\delta = 0.1$	-0.071	0.024	-0.080	0.429*	0.017	0.044	-0.031	-0.018
	(0.09)	(0.18)	(0.10)	(0.24)	(0.20)	(0.21)	(0.23)	(0.24)
$\delta = 0.25$		omitted category			0.169	0.196	-0.068	-0.067
					(0.11)	(0.12)	(0.14)	(0.15)
$\delta = 0.6$	-0.477***	-1.130***	-0.524***	-1.222***	0.360***	0.405***	-1.185***	-1.249***
	(0.11)	(0.22)	(0.12)	(0.24)	(0.11)	(0.12)	(0.24)	(0.26)
UBidder[a]	0.517**		0.582***					
	(0.20)		(0.22)					
$\times\delta = 0.1$[b]	0.047		0.077					
		(0.31)		(0.34)				
$\times\delta = 0.25$[b]		0.237		0.277				
		(0.15)		(0.20)				
$\times\delta = 0.6$[b]		1.545***		1.687***				
		(0.24)		(0.29)				
Constant	3.383***	3.522***	3.405***	3.553***	3.296***	3.299***	3.284***	3.283***
	(0.14)	(0.11)	(0.15)	(0.12)	(0.11)	(0.11)	(0.10)	(0.11)
N	9600	9600	9600	9600	9600	9600	9600	9600

Notes: Robust standard errors in parentheses (clustered at matching group level). Specifications (5)-(8) include period fixed effects. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. [a] U: unreliable bidder, S: standard bidder, SP: second-price auction ($\delta = 0$). [b] Interaction effects unreliable bidder $\times$ default probability.

Table A.2: Regressions for average bids on values 2 and 4 (across-bidder comparisons)

	Comparisons				
	within bidder type		across-bidder type	with SP	
	Unreliable	Standard	Unreliable vs Standard	Unreliable	Standard
	$\delta = 0.1$ vs $\delta = 0.25$		$\delta = 0.25$		
bid($v = 0$)	$-^{***}$	$-^{***}$	·	·	·
bid($v = 2$)	$-^{**}$	·	·	·	·
bid($v = 4$)	·	·	·	$+^{**}$	·
	$\delta = 0.6$ vs $\delta = 0.25$		$\delta = 0.1$		
bid($v = 0$)	·	$-^{***}$	·	·	·
bid($v = 2$)	$+^{**}$	$-^{***}$	·	·	·
bid($v = 4$)	·	$-^{***}$	·	·	·
	$\delta = 0.6$ vs $\delta = 0.1$		$\delta = 0.6$		
bid($v = 0$)	·	$-^{**}$	$+^{*}$	·	$-^{**}$
bid($v = 2$)	·	$-^{***}$	$+^{***}$	$+^{***}$	$-^{***}$
bid($v = 4$)	$+^{**}$	$-^{**}$	$+^{***}$	$+^{**}$	$-^{***}$

Notes: Signs of coefficients from ordered logit regressions. · no significant difference, + significantly higher bid, − significantly lower bid. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A.3: Ordered logit regressions (two-bidder experiments)

	2-bidder experiments			3-bidder experiments		
	Part 1	Part 2	Overbidding	Part 1	Part 2	Overbidding
Treatment	(Periods 1-50)	(51-100)	allowed	(Periods 1-50)	(51-100)	allowed
SP	$\delta = 0$	$\delta = 0$	Yes(N=48)/–	$\delta = 0$	$\delta = 0$	Yes(N=18)/no(N=18)
HD	$\delta = 1/4$	$\delta = 3/5$	Yes(N=48)/–	$\delta = 1/2$	$\delta = 3/5$	Yes(N=18)/no (N=18)
LD	$\delta = 1/4$	$\delta = 1/10$	Yes(N=48)/–	$\delta = 1/2$	$\delta = 1/6$	Yes(N=18)/no(N=18)
D0	–	–	–	$\delta = 1/2$	$\delta = 0$	Yes(N=18)/no(N=18)

Notes: Two-bidder experiments: Two sessions per treatment with 24 subjects each (four matching groups). Three-bidder experiments: Two sessions per treatment with 9 subjects each (one matching group).

Table A.4: Overview of treatments

E Three-bidder experiments

We also ran experiments based on the three-bidder model in Section C.2. Table A.4 gives an overview. Experimental procedures and instructions were parallel to those in the two-bidder experiments, except for the following differences: (i) The specific default probabilities implemented were chosen to fit the predictions for the 3-bidder model. (ii) We also ran sessions were unreliable bidders had a default probability of 50 percent in periods 1-50 (as in LD and HD) but then became standard bidders, i.e., all three bidders had a default probability of zero in periods 51-100 (as in SP). (iii) We also ran sessions were overbidding was not possible (i.e. allowed bids were the integers up to v instead of $\{0, \ldots, 5\}$). (iv) We used matching groups of nine, with six standard bidders and three unreliable bidders. For each treatment there were two sessions with nine participants each, i.e. a total of 16 sessions with 144 participants. The hypotheses are parallel to those in the paper, with the specific predictions for equilibrium bids given in Proposition A.2.

E.1 Results

E.1.1 Main treatments

Our main treatments for the three-bidder experiments allowed overbidding (like in the two-bidder experiments). Table A.5 provides summary statistics. We report results from the regressions of average bids on values 2 and 4 from within-bidder type comparisons in Table A.6 and from comparisons across bidder types or with a standard second-price auction, respectively, in Table A.7.

Overall, we find that the default probability has little impact on the unreliable bidders' behavior, in line with the theory. Specifications (1) and (3) in Table A.6 reveal no significant effect.

Specification (5) compares bidding behavior in part 2 of treatment $D0$ (where $\delta = 0$) with that in part 2 of treatments LD (where $\delta = 1/6$) and HD (where $\delta = 3/5$). Note that there was no treatment difference in part 1, where all had $\delta = 1/2$. Results indicate (unexpectedly) significantly lower bids when $\delta = 1/6$ vs $\delta = 0$, but no significant difference between bidding behavior when $\delta = 1/6$ and $\delta = 3/5$.

Standard bidders lower their bids when $\delta = 3/5$ compared to $\delta = 1/6$ (specifications (2) and (6)) and bid higher when $\delta = 1/6$ vs $\delta = 1/2$ (specification (2)), as predicted by the theory. Specification (4) however shows no significant effect of $\delta = 1/2$ on bids, which could indicate that it takes experience to start lowering bids because $\delta = 1/2$ occurs in part 1 whereas $\delta = 1/6$ or $\delta = 3/5$ occur in part 2.

Having been exposed to a default probability $\delta = 1/2$ in part 1 as an unreliable or standard bidder does not significantly affect bidding behavior subsequently in a standard second-price auction, as specification (7) in Table A.6 reveals by comparing bids in part 2 of treatments SP and $D0$.

Standard bidders bid significantly lower than unreliable bidders for $\delta = 3/5$, as predicted by the theory (indicated by the interaction effect in specification (2) in Table A.7). Comparison with bidding in a second-price auction reveals no difference for unreliable bidders but lower bids for standard bidders for $\delta = 1/2$ and $\delta = 3/5$ (specifications (3) and (4) in Table A.7, respectively) – again in line with the theory except that it would also predict standard bidders to bid lower with $\delta = 1/6$.

Results are robust to using tobit regressions (available upon request) and are similar to the conclusions from ordered logit regressions (see Table A.8).

Default		Part 1 (periods 1-50)			Part 2 (periods 51-100)		
probability	Value	0	2	4	0	2	4
$\delta = 0^a$		0.33	2.61	4.46	0.30	2.46	4.34
(SP)		(0.81)	(0.84)	(0.58)	(0.88)	(0.82)	(0.67)
	Obs.	900	900	900	900	900	900
$\delta = 1/2$	UBidder[c]	0.83	2.54	4.13	–	–	–
(LD & HD)		(1.11)	(0.99)	(0.96)			
	Obs.	600	600	600	–	–	–
	SBidder[d]	0.36	2.17	3.85	–	–	–
		(0.91)	(0.80)	(0.92)			
	Obs.	1200	1200	1200	–	–	–
$\delta = 1/6$	UBidder	–	–	–	0.47	2.27	4.36
(LD)					(0.80)	(0.79)	(0.82)
	Obs.	–	–	–	300	300	300
	SBidder	–	–	–	0.31	2.36	4.17
					(0.74)	(0.70)	(0.65)
	Obs.	–	–	–	600	600	600
$\delta = 3/5$	UBidder	–	–	–	0.78	2.56	4.33
(HD)					(0.90)	(0.94)	(0.70)
	Obs.	–	–	–	300	300	300
	SBidder	–	–	–	0.05	1.83	3.91
					(0.23)	(0.53)	(0.72)
	Obs.	–	–	–	600	600	600
$D0^b$	UBidder	0.51	2.81	4.59	0.31	2.46	4.62
		(0.94)	(0.91)	(0.66)	(0.46)	(0.61)	(0.52)
	Obs.	300	300	300	300	300	300
	SBidder	0.28	2.19	4.37	0.47	2.46	4.50
		(0.58)	(0.98)	(0.99)	(0.82)	(0.77)	(0.63)
	Obs.	600	600	600	600	600	600

Notes: Average bids. Standard deviation in parentheses. [a] Second-price auction.
[b] In $D0$, part 1 has $\delta = 1/2$ and part 2 has $\delta = 0$. [c] Unreliable bidder.
[d] Standard bidder. 72 subjects (18 subjects per treatment).

Table A.5: Summary statistics for average bids in the three-bidder experiments (main treatments with overbidding allowed)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	UvsU[a]	SvsS[a]	U(D0)vsU(D0)[c]	S(D0)vsS(D0)[c]	UvsU(D0)	SvsS(D0)	SP(D0)vsSP[a]
SP[a]	omitted category						
$\delta = 1/6$	0.077	0.156***			-0.223**	-0.215	
	(0.16)	(0.01)			(0.07)	(0.15)	
$\delta = 1/2$	omitted category		0.165	-0.199			
			(0.27)	(0.08)			
$\delta = 3/5$	0.020	-0.040††			-0.093	-0.608***††	
	(0.21)	(0.04)			(0.15)	(0.04)	
UBidder[b]							0.139
							(0.19)
SBidder[b]							0.083
							(0.18)
Constant	3.330***	3.010***	3.537**	3.480***	3.606***	3.344***	3.366***
	(0.07)	(0.01)	(0.14)	(0.04)	(0.08)	(0.08)	(0.23)
Bidder FE	Yes	Yes	Yes	Yes	No	No	No
R^2	0.002	0.013	0.023	0.033	0.033	0.172	0.018
N	1200	2400	600	1200	900	1800	1800
Identification	$LD + HD$, part 1 vs 2		$D0$, part 1 vs 2		$D0$ vs $LD + HD$, part 2		$D0$ vs SP, part 2

Notes: Robust standard errors in parentheses (clustered at matching group level). Specifications (5)-(7) include period fixed effects. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. †† Coefficients $\delta = 3/5$ and $\delta = 1/6$ significantly different ($p < 0.05$).

[a] U: unreliable bidder, S: standard bidder, SP: second-price auction ($\delta = 0$), SP(D0): part 2 in treatment $D0$ ($\delta = 0$).

[b] U-/SBidder: dummy for having been an unreliable/standard bidder in part 1 of treatment $D0$.

[c] Treatment $D0$ allows within-bidder type comparison of $\delta = 1/2$ (periods 1-50) with $\delta = 0$ (periods 51-100).

Table A.6: Regressions for average bids on values 2 and 4 for the three-bidder experiments (comparisons within bidder type, main treatments with overbidding allowed)

Variable	(1)	(2)	(3)	(4)
	UvsS[a]	UvsS	UvsSP[a]	SvsSP
SP[a]			omitted category	
$\delta = 1/6$	0.164	0.255*	-0.084	-0.132
	(0.08)	(0.10)	(0.17)	(0.22)
$\delta = 1/2$	omitted category		-0.207	-0.526**††
			(0.19)	(0.18)
$\delta = 3/5$	-0.055	-0.139	0.046	-0.526**††
	(0.08)	(0.10)	(0.21)	(0.17)
UBidder[a]	0.315			
	(0.18)			
$\times\delta = 1/6^b$		0.048		
		(0.16)		
$\times\delta = 1/2^b$		0.320		
		(0.20)		
$\times\delta = 3/5^b$		0.572**		
		(0.11)		
Constant	3.012***	3.010***	3.199***	3.301***
	(0.09)	(0.10)	(0.14)	(0.12)
R^2	0.057	0.072	0.034	0.135
N	3600	3600	3000	4200
Identification	*LD* & *HD*, parts 1 & 2		*SP*, *LD* & *HD*, parts 1 & 2	

Notes: Robust standard errors in parentheses (clustered at matching group level).
Specifications (3)-(4) include period fixed effects. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.
†† Coefficient significantly different from coefficient $\delta = 1/6$ ($p < 0.05$).
[a] U: unreliable bidder, S: standard bidder, SP: second-price auction ($\delta = 0$).
[b] Dummy for unreliable bidder.
[c] Interaction effects unreliable bidder $\times$ default probability.

Table A.7: Regressions for average bids on values 2 and 4 for the three-bidder experiments (comparisons across bidder type and with standard second-price auction, main treatments with overbidding allowed)

	Comparisons				
	within bidder type		across-bidder type	with SP	
	Unreliable	Standard	Unreliable vs Standard	Unreliable	Standard
	$\delta = 1/6$ vs $\delta = 1/2$		$\delta = 1/2$		
bid($v = 0$)	$-^{*}$	·	$+^{*}$	$+^{***}$	·
bid($v = 2$)	·	$-^{***}$	·	·	$-^{*}$
bid($v = 4$)	·	$+^{***}$	·	·	$-^{***}$
	$\delta = 3/5$ vs $\delta = 1/2$		$\delta = 1/6$		
bid($v = 0$)	$-^{*}$	·	·	·	·
bid($v = 2$)	·	·	$-^{**}$	·	·
bid($v = 4$)	·	·	·	·	·
	$\delta = 3/5$ vs $\delta = 1/6$		$\delta = 3/5$		
bid($v = 0$)	·	·	$+^{***}$	$+^{*}$	·
bid($v = 2$)	·	$-^{**}$	$+^{***}$	·	$-^{***}$
bid($v = 4$)	·	$-^{*}$	$+^{***}$	·	$-^{**}$

Notes: Signs of coefficients from ordered logit regressions. · no significant difference, + significantly higher bid, − significantly lower bid. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A.8: Ordered logit regressions (three-bidder experiments, main treatments with overbidding allowed)

E.1.2 Treatments with no overbidding allowed

For these three-bidder experiments we also ran treatments where no overbidding was allowed, i.e. bids where restricted to the integers up to the bidder's value: $\{0, \ldots, v\}$. Table A.9 provides summary statistics for the three-bidder experiments. Tables A.10 and A.11 report results from the regressions of average bids on values 2 and 4 from within-bidder type comparisons and comparisons across bidder types or with a standard second-price auction, respectively.

Note first that capping the bid range at the value v restricts possible variation in bids relative to the main treatments, which makes it more difficult to detect differences in bidding behavior across bidder types and default probabilities. In line with our previous results we see that standard bidders bid less with $\delta = 3/5$ than with $\delta = 1/6$ in specification (2) in Table A.10, but find no systematic effects in the other specifications. In contrast to our previous results, unreliable bidders appear to bid higher in part 2, possibly reflecting frustration with frequently failing to get a net payoff in part 1 on account of default (specification (1) in Table A.10). There is a borderline significant negative effect of having a default probability $\delta = 1/2$ in part 1 relative to never defaulting (specification (3)). Similarly, the ordered logit regressions in Table A.12 show mixed results. But they reveal that – in line with the theory – for all default probabilities standard bidders tend to bid less than in the standard second-price auction (these effects were not significant in the regressions for average bids on values 2 and 4).

Default		Part 1 (periods 1-50)			Part 2 (periods 51-100)		
probability	Value	0	2	4	0	2	4
$\delta = 0^a$		0.00	1.85	3.87	0.00	1.93	3.92
(SP)		(0.00)	(0.43)	(0.38)	(0.00)	(0.34)	(0.38)
	Obs.	900	900	900	900	900	900
$\delta = 1/2$	UBidder[c]	0.00	1.74	3.68	–	–	–
(LD & HD)		(0.00)	(0.49)	(0.64)			
	Obs.	600	600	600	–	–	–
	SBidder[d]	0.00	1.69	3.49	–	–	–
		(0.00)	(0.51)	(0.81)			
	Obs.	1200	1200	1200	–	–	–
$\delta = 1/6$	UBidder	–	–	–	0.00	1.87	3.83
(LD)					(0.00)	(0.34)	(0.47)
	Obs.	–	–	–	300	300	300
	SBidder	–	–	–	0.00	1.74	3.66
					(0.00)	(0.45)	(0.54)
	Obs.	–	–	–	600	600	600
$\delta = 3/5$	UBidder	–	–	–	0.00	1.79	3.78
(HD)					(0.00)	(0.41)	(0.46)
	Obs.	–	–	–	300	300	300
	SBidder	–	–	–	0.00	1.75	3.61
					(0.00)	(0.45)	(0.72)
	Obs.	–	–	–	600	600	600
$D0^c$	UBidder	0.00	1.69	3.82	0.00	1.86	3.87
		(0.00)	(0.55)	(0.49)	(0.00)	(0.36)	(0.40)
	Obs.	300	300	300	300	300	300
	SBidder	0.00	1.63	3.31	0.00	1.73	3.47
		(0.00)	(0.55)	(0.97)	(0.00)	(0.54)	(1.00)
	Obs.	600	600	600	600	600	600

Notes: Average bids. Standard deviation in parentheses. [a] Second-price auction. [b] In $D0$, part 1 has $\delta = 1/2$ and part 2 has $\delta = 0$. [c] Unreliable bidder. [d] Standard bidder. 72 subjects (18 subjects per treatment)

Table A.9: Summary statistics for average bids in the three-bidder experiments (no overbidding allowed)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	UvsU[a]	SvsS[a]	U(D0)vsU(D0)[c]	S(D0)vsS(D0)[c]	UvsU(D0)	SvsS(D0)	SP(D0)vsSP[a]
SP[a]			omitted category				
$\delta = 1/6$	0.153**	0.078**			-0.015	0.100	
	(0.03)	(0.02)			(0.06)	(0.16)	
$\delta = 1/2$	omitted category		-0.110*	-0.132			
			(0.02)	(0.26)			
$\delta = 3/5$	0.110**	0.003††			-0.085	0.080	
	(0.01)	(0.04)			(0.11)	(0.14)	
UBidder[b]							-0.053
							(0.09)
SBidder[b]							-0.322*
							(0.10)
Constant	2.687***	2.650***	2.868*	2.600**	2.728***	2.523***	2.797***
	(0.01)	(0.01)	(0.01)	(0.13)	(0.09)	(0.09)	(0.10)
Bidder FE	Yes	Yes	Yes	Yes	No	No	No
R^2	0.037	0.008	0.031	0.017	0.039	0.021	0.110
N	1200	2400	600	1200	900	1800	1800
Identification	$LD + HD$, part 1 vs 2		$D0$, part 1 vs 2		$D0$ vs $LD + HD$, part 2		$D0$ vs SP, part 2

Notes: Robust standard errors in parentheses (clustered at matching group level). (5)-(7) include period fixed effects. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. †† Coefficients $\delta = 3/5$ and $\delta = 1/6$ significantly different ($p < 0.05$).

[a] U: unreliable bidder, S: standard bidder, SP: second-price auction ($\delta = 0$), SP(D0): part 2 in treatment $D0$ ($\delta = 0$).

[b] U-/SBidder: dummy for having been an unreliable/standard bidder in part 1 of treatment $D0$.

[c] Treatment $D0$ allows within-bidder type comparison of $\delta = 1/2$ (periods 1-50) with $\delta = 0$ (periods 51-100).

Table A.10: Regressions for average bids on values 2 and 4 for the three-bidder experiments (comparisons within bidder type, no overbidding allowed)

Variable	(1)	(2)	(3)	(4)
	UvsS[a]	UvsS	UvsSP[a]	SvsSP
SP[a]			omitted category	
$\delta = 1/6$	0.089	0.050	-0.068	-0.222
	(0.07)	(0.09)	(0.06)	(0.16)
$\delta = 1/2$	omitted category		-0.173*	-0.210
			(0.07)	(0.12)
$\delta = 3/5$	0.053	0.030	-0.138	-0.242
	(0.09)	(0.11)	(0.11)	(0.11)
UBidder[a]	0.083			
	(0.08)			
$\times\delta = 1/6^b$		0.153		
		(0.15)		
$\times\delta = 1/2^b$		0.037		
		(0.07)		
$\times\delta = 3/5^b$		0.103**		
		(0.03)		
Constant	2.634***	2.650***	2.703***	2.656***
	(0.11)	(0.11)	(0.08)	(0.08)
R^2	0.041	0.017	0.091	0.090
N	3600	3600	3000	4200
Identification	*LD* & *HD*, parts 1 & 2		*SP*, *LD* & *HD*, parts 1 & 2	

Notes: Robust standard errors in parentheses (clustered at matching group level).
Specifications (3)-(4) include period fixed effects. $^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.
[a] U: unreliable bidder, S: standard bidder, SP: second-price auction ($\delta = 0$).
[b] Dummy for unreliable bidder.
[c] Interaction effects unreliable bidder $\times$ default probability.

Table A.11: Regressions for average bids on values 2 and 4 for the three-bidder experiments (comparisons across bidder type and with standard second-price auction, no overbidding allowed)

	Comparisons				
	within bidder type		across-bidder type	with SP	
	Unreliable	Standard	Unreliable vs Standard	Unreliable	Standard
	$\delta = 1/6$ vs $\delta = 1/2$		$\delta = 1/2$		
bid($v = 0$)			no variation in bids possible		
bid($v = 2$)	$+^{*}$	$\cdot$	$\cdot$	$-^{*}$	$-^{*}$
bid($v = 4$)	$+^{***}$	$+^{***}$	$\cdot$	$-^{**}$	$-^{*}$
	$\delta = 3/5$ vs $\delta = 1/2$		$\delta = 1/6$		
bid($v = 0$)			no variation in bids possible		
bid($v = 2$)	$+^{*}$	$+^{***}$	$\cdot$	$\cdot$	$-^{*}$
bid($v = 4$)	$+^{***}$	$-^{***}$	$\cdot$	$\cdot$	$-^{*}$
	$\delta = 3/5$ vs $\delta = 1/6$		$\delta = 3/5$		
bid($v = 0$)			no variation in bids possible		
bid($v = 2$)	$\cdot$	$\cdot$	$+^{*}$	$\cdot$	$-^{*}$
bid($v = 4$)	$\cdot$	$\cdot$	$\cdot$	$\cdot$	$-^{**}$

Notes: Signs of coefficients from ordered logit regressions. $\cdot$ no significant difference, $+$ significantly higher bid, $-$ significantly lower bid. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A.12: Ordered logit regressions (three-bidder experiments, no overbidding allowed)

F Instructions from the experiments

We provide here the instructions from the two-bidder experiments. Instructions from the three-bidder experiments are parallel to them. Before the experiment started, participants received a set of instructions for part 1 of the experiment (periods 1-50). After period 50, subjects in the treatments LD and HD received instructions for part 2. Subjects in treatment SP just had a short break, as nothing changed compared to part 1.

F.1 Instructions for part 1 (treatments LD and HD)

You are now taking part in an experiment. If you read the following instructions carefully, you can, depending on your and other participants' decisions, earn a considerable amount of money. It is therefore important that you take your time to understand the instructions. Please do not communicate with the other participants during the experiment. If you have any questions, please raise your hand and we will come to your seat.

All the information you provide will be treated anonymously.

At the end of the experiment your earnings will be converted from Experimental Currency Units (ECU) to Pounds Sterling at a rate of **£ 1 = ECU 4**, and paid to you in cash. Your earnings will be treated confidentially.

Think carefully about your choices, making sure that you understand the rules as explained in these instructions. **Bad choices will lead to lower earnings for you.** At the beginning, you receive a starting budget of ECU 20. Gains will be added to your earnings, and losses deducted, giving your take-home pay at the end of the experiment.

OVERVIEW OF THE EXPERIMENT

The experiment consists of two parts and your earnings will depend on both parts. During each of these parts you will participate in 50 auctions, so there is a total of 100 auctions. We describe here the first part of the experiment. The second part is similar and you will receive some additional instructions before its start. Your earnings in the experiment are the sum of your earnings from each auction plus the starting budget of ECU 20.

In each auction, you and another person bid for a fictitious object. The person submitting the highest bid for the object wins the auction. Sometimes, however, the winning bid may be cancelled by the computer programme. In that case, the other bidder ends up winning the object. This will be explained in detail below.

Bidder types

There are two types of bidders, Standard Bidders and Precarious Bidders.

- If a **Standard Bidder wins the auction**, he or she always obtains the object and pays the price determined in the auction.
  - If a **Precarious Bidder wins the auction**, there is a 25 percent chance (i.e. 1 in 4 chance) that the computer programme cancels his or her bid.
  - If the Precarious Bidder's **bid is <u>not</u> cancelled**, he or she obtains the object and pays the price determined in the auction.
  - If the Precarious Bidder's **bid is cancelled**, he or she does not obtain the object and does not pay anything. In that case, the object is won by the other bidder, who then pays the price determined in the auction.

The cancellation of the bid is beyond the control of the Precarious Bidder. Also, the Precarious Bidder will not learn before bidding whether there will be a cancellation of his or her bid in the event of winning the auction.

You can think of a situation where bidding for the object and payments are happening on-line, and the Precarious Bidder has a poor internet connection. In 25% of the cases, the internet connection used for sending the payment fails and the auctioneer cancels the bid.

In the beginning of the experiment each participant learns whether he or she is a Standard or a Precarious Bidder. **You will keep the same bidder type in all auctions.** That is, if you are a Standard Bidder you will stay a Standard Bidder in both parts of the experiment, and if you are a Precarious Bidder you will stay a Precarious Bidder in both parts of the experiment.

What is the price of the object?

In this experiment, we will have auctions with two bidders. The auctions will be 'second price' auctions. This means that each of the two bidders will place a bid for the object. The person submitting the highest bid wins the auction, but the price he or she has to pay is the second highest bid, which for auctions with two bidders is simply the lowest of the two bids.

- If, for example, the bids are 60 and 30, then the bidder who bids 60 (the highest bid) wins the object, but only has to pay 30 (the lowest bid).
- If, for example, the bids are 30 and 30, then there is a tie. The highest and the second highest bids are equal. The computer chooses a winner with a random draw. The winner pays 30, which is the bid placed by the other person (which in this case is equal to the winner's own bid).

Who gets the object if a <u>Standard Bidder</u> wins the auction?

The Standard Bidder. He or she gets the object and pays the auction price.

Who gets the object if a <u>Precarious Bidder</u> wins the auction?

The computer may cancel the Precarious Bidder's bid. This will happen on average in one out of four cases where the Precarious Bidder wins.

If the bid is cancelled, the object is won instead by the other bidder. This bidder will then have to pay as much as the Precarious Bidder would have had to pay if the winning bid had not been cancelled. This means, in this situation, the bidder would actually pay his or her own bid.

If, for example, the Precarious Bidder bids 60 and the other bidder bids 30, then the Precarious Bidder wins the auction.

- If the bid is not cancelled he or she gets the object and pays 30 (the lowest bid).
- If the bid is cancelled, the bidder who bid 30 gets the object and pays 30.

Note: the numbers in the examples are a lot different than in our experiment today.

HOW AN AUCTION IN THE EXPERIMENT WORKS

In each auction, the computer will create groups of two participants to bid for a fictitious object. In each group there will be **one Standard Bidder** and **one Precarious Bidder**.

- If you are a Precarious Bidder, you will always be in a group with one Standard Bidder.
- If you are a Standard Bidder, you will always be in a group with one Precarious Bidder.

Every time a new auction starts, the computer creates new groups by choosing randomly among the Standard and Precarious Bidders. Therefore, you will generally be with a different bidder in different auctions.

The auctioned object is worth either **ECU 0, 2, or 4** to you. Your **valuation** (what the object is worth to you) is randomly determined by the computer, and each of the three valuations is equally likely.

- In case you win the object, you pay the price determined in the auction. Your **earnings** in the auction are equal to your **valuation** (the object's worth to you)**minus** the auction **price**.
- In case you do not win the object, you do not have to pay anything. So your earnings for the auction are zero.

How do you bid in the experiment?

Before you learn what your valuation is, you tell the computer in advance how much you will bid in each of the three possible cases. Thus at the beginning of each auction, you answer the following three questions:

1. How much do you bid if your valuation for the object turns out to be ECU 0?
2. How much do you bid if your valuation for the object turns out to be ECU 2?
3. How much do you bid if your valuation for the object turns out to be ECU 4?

Possible bids are the integer amounts **ECU 0, 1, 2, 3, 4, and 5**.

You can view this information as 'programming the computer'. Entering this bid programme in each auction is your only task.

In each auction, the computer randomly determines your valuation and then submits your bid, based on your bid programme (your answers to questions 1, 2, and 3). The computer does the same for the other bidder, based upon the bid programme he or she gave the computer.

When you fill in your list of bids you do not know what your valuation or the valuation of the other participant in the auction will be. All you know is that it is equally likely that your valuation is ECU 0, 2, or 4, and that the valuation for the other participant in the auction also is equally likely to be ECU 0, 2, or 4.

The computer randomly determines new valuations for each participant in each of the auctions. Valuations are independent. This means that the chance that your valuation turns out to be 0, 2, or 4 is always the same, no matter what the valuation of the other bidder is and no matter what your valuation in the last auction was.

At the end of each auction you receive information on the screen about the auction outcome and your earnings from this auction, as well as your current balance.

You can choose a new bid programme for the computer for the next auction, or re-enter the same bid programme again. Think carefully about your bid programme. If you win the auction with a bid that is higher than your valuation, then the price that you end up paying may also be higher than your valuation. **In that case your earnings will be negative**. This loss will be deducted from your current balance. If your current balance drops below zero you may be excluded from the experiment and receive a total payment of £0 for the experiment.

We will now go through a few examples and ask you to then fill in a questionnaire to make sure that the instructions are clear to you. If you have any questions, please raise your hand for one of the experimenters to come over. The experiment will start when all participants have finished with their questionnaire.

An example illustrating the experiment (the bid programmes are just for illustration and not suggestions for 'good' play)

1.

Precarious Bidder fills in bid programme

bid if valuation is 0: **3**
bid if valuation is 2: **3**
bid if valuation is 4: **3**

Standard Bidder fills in bid programme

bid if valuation is 0: **2**
bid if valuation is 2: **5**
bid if valuation is 4: **4**

2. **Computer randomly draws valuations for each bidder**

valuations 0, 2, and 4 equally likely; draws are independent for each bidder

Precarious Bidder: valuation in this auction: **4**

Standard Bidder: valuation in this auction: **0**

3. **Computer submits bids according to bid programmes**

Precarious Bidder:

bid if valuation is 0: **3**
bid if valuation is 2: **3**
bid if valuation is 4: **3**

bid in this auction: **3**

Standard Bidder:

bid if valuation is 0: **2**
bid if valuation is 2: **5**
bid if valuation is 4: **4**

bid in this auction: **2**

4. **Computer determines auction winner and price**

Highest bid **3** → Precarious Bidder wins

Lowest bid **2** → price = **2**

Case 1: Computer cancels the Precarious Bidder's bid
(25% chance, i.e. 1 out of 4 cases on average)

Precarious Bidder — Earnings: **0**

Lowest bidder gets object

Standard Bidder — Earnings: **0** – **2** = **–2**
(valuation – price)

Case 2: Computer does not cancel the Precarious Bidder's bid
(75% chance, i.e. 3 out of 4 cases on average)

Precarious Bidder gets object

Precarious Bidder — Earnings: **4** – **2** = 2
(valuation – price)

Standard Bidder — Earnings: **0**

F.2 Questionnaire for part 1 (treatments LD and HD)

1. Bids submitted in the auction: 2 and 4.

   What is the price for the object in this auction?

2. Bids submitted in the auction: 4 and 4.

   What is the price for the object in this auction?

3. You are a Standard Bidder. Your bid programme:

   - Your bid if your valuation turns out to be 0: 3
   - Your bid if your valuation turns out to be 2: 5
   - Your bid if your valuation turns out to be 4: 4

   Your valuation turns out to be 4.

   Bid of the Precarious Bidder in the auction: 1.

   (a) Who wins the auction? Tick the correct answer. ☐ I win ☐ The Precarious Bidder wins

   (b) What is the price for the object in this auction?

   (c) What are your earnings in this auction?

4. Tick the correct answers:

   - The Standard Bidder wins the auction. Possible outcome?
     The computer cancels the Standard Bidder's bid ☐ yes ☐ no
   - The Precarious Bidder wins the auction. Possible outcome?
     The computer cancels the Precarious Bidder's bid ☐ yes ☐ no

5. Tick the correct answer. In each auction

   ☐ there are exactly 1 Precarious Bidder and 1 Standard Bidder.

   ☐ there also can be 2 Precarious Bidders or 2 Standard Bidders.

6. Tick the correct answer. The other bidder besides you

   ☐ is the same in each auction.

   ☐ is reshuffled among the participants for each auction.

7. You are the Precarious Bidder. Your valuation: 0. You win the auction with a bid of 5. The Standard Bidder has valuation 4. Her bid in the auction: 2.

   (a) Suppose your winning bid is not cancelled.

   - What are your earnings in the auction?
   - What are the earnings of the Standard Bidder?

   (b) Suppose your winning bid is cancelled.

   - What are your earnings in the auction?
   - What are the earnings of the Standard Bidder?

8. You are the Standard Bidder. Your valuation: 4. Your bid in the auction: 1. Bid of the Precarious Bidder: 0.

   (a) Who wins the auction? Tick the correct answer.

   ☐ you win.

   ☐ the Precarious Bidder wins.

   (b) What is the price for the object in this auction?

   (c) What are your earnings in this auction?

   (d) What are the earnings of the Precarious Bidder?

When you have finished raise your hand for one of the experimenters to come over.

F.3 Instructions for part 2 (treatments LD and HD)

Note: for treatment LD replace 60 percent with 16.66 percent

Additional Instructions: Part 2

You have now completed the first of two parts in the experiment. In the second part you will again participate in 50 auctions.
There is only **one difference** from the auctions in the first part:
If the **Precarious Bidder wins** the auction, there is now a **60 percent** chance that the computer programme cancels his or her bid.

- That is, if the Precarious Bidder wins, on average in 3 out of 5 cases his or her bid is cancelled and the Precarious Bidder does not obtain the object and does not pay anything. Then, the object is won by the other bidder, who then pays the auction price.

- In the remaining cases where the bid of the Precarious Bidder is not cancelled after winning the auction, he or she obtains the good and pays the auction price.

You keep the same role as in the first part. That is, if you were a Standard Bidder you stay a Standard Bidder, and if you were a Precarious Bidder you stay a Precarious Bidder. Also, the rules of the auctions are the same as in the first part of the experiment.

F.4 Instructions for treatment SP

The introductory paragraphs are as in part 1 of treatments LD *and* HD*.*

OVERVIEW OF THE EXPERIMENT

The experiment consists of two parts and your earnings will depend on both parts. During each of these parts you will participate in 50 auctions, so there is a total of 100 auctions. Your earnings in the experiment are the sum of your earnings from each auction plus the starting budget of ECU 20.

In each auction, you and another person bid for a fictitious object. The person submitting the highest bid for the object wins the auction and pays as price what the bid was by the other person, who did not win the auction. This will be explained in detail below.

What is the price of the object?

In this experiment, we will have auctions with two bidders. The auctions will be 'second price' auctions. This means that each of the two bidders will place a bid for the object. The person submitting the highest bid wins the auction, but the price he or she has to pay is the second highest bid, which for auctions with two bidders is simply the lowest of the two bids.

- If, for example, the bids are 60 and 30, then the bidder who bids 60 (the highest bid) wins the object, but only has to pay 30 (the lowest bid).

- If, for example, the bids are 30 and 30, then there is a tie. The highest and the second highest bids are equal. The computer chooses a winner with a random draw. The winner pays 30, which is the bid placed by the other person (which in this case is equal to the winner's own bid).

Note: the numbers in the examples are a lot different than in our experiment today.

HOW AN AUCTION IN THE EXPERIMENT WORKS

In each auction, the computer will create groups of two participants to bid for a fictitious object. Every time a new auction starts, the computer creates new groups by choosing randomly among participants. Therefore, you will generally be with a different bidder in different auctions.

The auctioned object is worth either **ECU 0, 2, or 4** to you. Your **valuation** (what the object is worth to you) is randomly determined by the computer, and each of the three valuations is equally likely.

- In case you win the object, you pay the price determined in the auction. Your **earnings** in the auction are equal to your **valuation** (the object's worth to you) **minus** the auction **price**.
- In case you do not win the object, you do not have to pay anything. So your earnings for the auction are zero.

How do you bid in the experiment?

The remainder is as in part 1 of treatments LD *and* HD.

An example illustrating the experiment (the bid programmes are just for illustration and not suggestions for 'good' play)

1.

Bidder 1 fills in bid programme

bid if valuation is 0: **3**
bid if valuation is 2: **3**
bid if valuation is 4: **3**

Bidder 2 fills in bid programme

bid if valuation is 0: **2**
bid if valuation is 2: **5**
bid if valuation is 4: **4**

2. **Computer randomly draws valuations for each bidder**

valuations 0, 2, and 4 equally likely; draws are independent for each bidder

Bidder 1 — valuation in this auction: **4**

Bidder 2 — valuation in this auction: **0**

3. **Computer submits bids according to bid programmes**

Bidder 1:

bid if valuation is 0: **3**
bid if valuation is 2: **3**
bid if valuation is 4: **3**

bid in this auction: **3**

Bidder 2:

bid if valuation is 0: **2**
bid if valuation is 2: **5**
bid if valuation is 4: **4**

bid in this auction: **2**

4. **Computer determines auction winner and price**

Highest bid **3** → Bidder 1 wins auction

Lowest bid **2** → price = **2**

5. **Computer determines the earnings of the winner (Valuation – Price)**

Bidder 1 gets object

Earnings:
4 – **2** = 2
(valuation – price)

Earnings:
0

F.5 Questionnaire for treatment SP

1. Bids submitted in the auction: 2 and 4.

   What is the price for the object in this auction?

2. Bids submitted in the auction: 4 and 4.

   What is the price for the object in this auction?

3. Your bid programme:

   - Your bid if your valuation turns out to be 0: 3
   - Your bid if your valuation turns out to be 2: 5
   - Your bid if your valuation turns out to be 4: 4

   Your valuation turns out to be 4.

   Bid of the other bidder in the auction: 1.

   (a) Who wins the auction? Tick the correct answer. ☐ I win. ☐ The other bidder wins.

   (b) What is the price for the object in this auction?

   (c) What are your earnings in this auction?

4. Tick the correct answer. In each group

   ☐ there are exactly 2 bidders.

   ☐ there are varying numbers of bidders.

5. Tick the correct answer. The group of bidders

   ☐ is the same in each auction.

   ☐ is reshuffled among the participants for each auction.

6. Your valuation: 0. You win the auction with a bid of 5. The Standard Bidder has valuation 4. Her bid in the auction: 2.

   (a) What are your earnings in the auction?

   (b) What are the earnings of the other bidder?

7. Your valuation: 4. Your bid 3. The other bidder bids 3.

(a) What is the price of the auction?

(b) There is a tie for winning the auction. Suppose you win the random draw. What are your earnings in the auction?

(c) There is a tie for winning the auction. Suppose you lose the random draw. What are your earnings in the auction?

When you have finished raise your hand for one of the experimenters to come over.

References

Li, L. (2010): "Reputation, Trust, and Rebates: How Online Auction Markets Can Improve Their Feedback Mechanisms," *Journal of Economics & Management Strategy*, 19, 303–331.

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