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Does procedural fairness crowd out other-regarding concerns? A bidding experiment

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Abstract

Bidding rules that guarantee procedural fairness may induce more equilibrium bidding and moderate other-regarding concerns. In our experiment, we assume commonly known true values and only two bidders to implement a best-case scenario for other-regarding concerns. The two-by-two factorial design varies ownership of the single indivisible commodity (an outside seller versus collective ownership) and the price rule (first versus second price). Our results indicate more equilibrium behavior under the procedurally fair price rule, what, however, does not completely crowd out equality and efficiency seeking.

JEL classification: D44, C92

Keywords: Auctions, Fair Division Games, Procedural fairness

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1. Introduction

Procedural fairness, calling for equal treatment of all persons (like equal voting rights or equal chances of promotion), is an important requirement of institutional design in all the social sciences.[1] Other situations appealing to procedural fairness are sports contests where the rules for ranking individual athletes or teams have to be fair, and where "fair play" requires players only to comply with the rules without any reference to other-regarding concerns. Even in procedurally unfair situations (e.g., the well known ultimatum experiments surveyed by Camerer, 2003), however, the outcomes must by no means be unfair because in small group interactions agents often exhibit other-regarding concerns.

We report here on an experiment designed to study whether such other-regarding concerns mainly arouse in circumstances violating procedural fairness or are influential even when the rules are procedurally fair. In other words, our main research question is: do procedurally fair rules allow for more equilibrium behavior or do people entertain other-regarding concerns beyond their interest in procedural fairness? Addressing this question requires situations for which we can define procedural fairness in a convincing way, e.g. by axiomatically characterizing procedurally fair rules. One such situation is "bidding" for the allocation of an indivisible commodity (Güth, forthcoming). In this paper, we therefore focus on bidding institutions. To easily evoke other-regarding concerns, we provide complete information about reselling values and assume competition of only two bidders.

We study four different bidding rules varying, in a two-by-two factorial design, the ownership of the good to be allocated (auctions versus fair division games) and the price rule (first versus second price). In an auction, the good is owned by an outside party who sells it to the competing bidders in exchange for

[1] There has been a large amount of work on procedural fairness in the psychology literature (for summaries of earlier research see, e.g., Lind and Tyler, 1988; Tyler and Lind, 2000; Konow, 2003). In contrast, economists have paid much less attention to fair procedures. Economic studies focusing on the importance of procedural fairness to behavior include, e.g., Frey et al. (2004), Bolton et al. (2005), Chlaß et al. (2009).

a price. In a fair division game, the object is collectively owned by the group of bidders so that monetary compensation (from the winner to the losers) is called for. The (sum of) payment(s) by the winner equals the highest bid under the first-price rule and the second-highest bid under the second-price rule.

We characterize a bidding rule as procedurally fair if it satisfies (1) the axiom of envy-free net trades according to bids (i.e., given her bid no agent should prefer another agent's net trade to her own), and (2) the axiom of equal stated profits (i.e., the payoffs of all bidders are equal according to their bids). These two axioms imply that the object must be awarded to the highest bidder at a price equal to the highest bid that, in case of fair division games, is equally distributed among all bidders. Therefore, whereas the first price rule is procedurally fair, the second price rule is not because it violates the axiom of equal stated profits.[2] By comparing bidding behavior under these two price rules, we can thus investigate whether guaranteeing procedural fairness induces more self-interest (in the sense of benchmark bidding) and tempers other-regarding concerns. Furthermore, procedurally fair rules may bring on more "true value"-bidding.

In Section 2 we define procedurally fair bidding rules, whose solution behavior for the case of complete payoff information and only two bidders is derived in Section 3. How other-regarding concerns can be detected in our games is illustrated in Section 4. The experimental protocol to investigate the crowding out effect of procedural fairness is introduced in Section 5. The data are described and statistically analyzed in Section 6. Section 7 concludes.

2. Procedurally fair rules of bidding

Procedural fairness means that all agents (in the case at hand, all bidders) are treated in the same way. This excludes that the rules of bidding depend on the

[2] An even stronger deviation from procedural fairness (in the sense that both axioms are violated) would be the third price rule. This, however, would require at least three bidders, rendering payoff comparisons more difficult.

bidders' idiosyncratic characteristics, which are usually privately known. Thus, in the axiomatic characterization of procedurally fair bidding rules, we evaluate allocation results by stated values, namely the individual bids.

Consider an indivisible commodity which in case of an auction is owned by an outside seller, and in case of fair division is collectively owned by the group of bidders $N = \{1, \ldots, n\}$ with $N \in \mathbb{N}$, $n \geq 2$. Each bidder $i \in N$ has a private value v_i (≥ 0) for the object to be sold, and she must submit a bid b_i (≥ 0). In case of $b_i = v_i$ we will say that i bids truthfully. The rules of bidding determine for all possible bid vectors $\mathbf{b} = (b_1, \ldots, b_n)$ the winner $w(\mathbf{b}) \in N$ who buys the commodity, and the winner's payment. In an auction, this payment is the price $p(\mathbf{b})$ that the winner must pay to the outside seller. In a fair division game, the payments are the compensations $t_j(\mathbf{b})$ that the winner must pay to the losers $j \neq w(\mathbf{b})$.

The axiom of envy-free net trades according to bids asserts that according to her bid no bidder $i \in N$ prefers the net trade of another bidder in N to her own one. In case of fair division, this obviously requires $t_j(\mathbf{b}) = t(\mathbf{b})$ for all $j \neq w(\mathbf{b})$ and all possible bid vectors $\mathbf{b}$. For a unified treatment of auction and fair division games, we further impose $p(\mathbf{b}) := nt(\mathbf{b})$. Envy freeness of net trades according to bids implies

$$b_{w(\mathbf{b})} - p(\mathbf{b}) \geq 0 \geq b_j - p(\mathbf{b}) \quad \text{for all} \quad j \neq w(\mathbf{b})$$

in case of auction, and

$$b_{w(\mathbf{b})} - \frac{n-1}{n} p(\mathbf{b}) \geq \frac{p(\mathbf{b})}{n} \geq b_j - \frac{n-1}{n} p(\mathbf{b}) \quad \text{for all} \quad j \neq w(\mathbf{b})$$

in case of fair division. The left-hand side of these two inequalities means that $w(\mathbf{b})$ should prefer to buy the commodity at the price $p(\mathbf{b})$ to not trading; the right-hand side expresses that, according to their stated preferences, the non-winners $j \neq w(\mathbf{b})$ prefer not to buy the commodity at the price $p(\mathbf{b})$. Thus, the winner $w(\mathbf{b})$ is the highest bidder, and the price $p(\mathbf{b})$, which is equally shared in case of collective ownership, lies between the second highest and the highest bid.

Imposing additionally the axiom of equal stated profits, which affirms that all profits should be equal according to the stated values, we have that $p(\mathbf{b}) = b_{w(\mathbf{b})}$, i.e., the price must equal the highest bid.

Proposition *Envy free net trades and equal profits according to bids require, for all bid vectors* $\mathbf{b}$*, to sell the commodity to the highest bidder, i.e.,* $b_{w(\mathbf{b})} \geq b_j$ *for all* $j \neq w(\mathbf{b})$*, at a price equal to the highest bid, i.e.,* $p(\mathbf{b}) = b_{w(\mathbf{b})}$.

By applying the rules in the Proposition, we guarantee important requirements of procedural fairness, namely envy free net trades and equal profits as evaluated by bids. Does such strong form of procedural fairness already satisfy people's other-regarding concerns, therefore allowing for equilibrium behavior? To answer this question, we consider four different allocation rules to which we refer as game types: First Price Auction (A1), Second Price Auction (A2), First Price Fair Division Game (F1), and Second Price Fair Division Game (F2). While the first price rule (specifying that the object is awarded to the highest bidder at a price equal to her own bid) complies with the Proposition and is therefore procedurally fair, the second price rule (requiring the object to be awarded to the highest bidder, but at a price equal to the second highest bid) does not satisfy the axiom of equal stated profits and is not procedurally fair. We provide a best-case scenario for other-regarding concerns by considering only two bidders who have complete information about the true value v_i of each bidder $i = 1, 2$ for the commodity to be allocated. Payoff comparisons should be, in this case, rather straightforward.

3. The benchmark solutions

Let $\underline{v}$ and $\overline{v}$ (with $0 < \underline{v} < \overline{v}$) be the two bidders' commonly known values for the object to be sold. Denote by $\underline{V}$ and $\overline{V}$ the bidder with value $\underline{v}$ and $\overline{v}$, respectively. In the experiment both values and bids are integers, what we consider in our theoretical analysis whenever convenient.

For the first price auction (A1), all bids b_i ($i = \underline{V}, \overline{V}$) not smaller than one's own true value are weakly dominated. Eliminating all the weakly dominated bids of $\underline{V}$ allows bidder $\overline{V}$ to win by bidding $b_{\overline{V}} = \underline{v}$. Choosing $b_{\overline{V}} < \underline{v}$ offers $\underline{V}$ some chances of winning and obtaining a positive payoff. Thus, the equilibrium vector in weakly undominated strategies for A1 is $\mathbf{b}^* = (b^*_{\underline{V}}, b^*_{\overline{V}})$ with $b^*_{\underline{V}} = \underline{v} - 1$ and $b^*_{\overline{V}} = \underline{v}$.

For the second price auction (A2), only general truthful bidding is weakly undominated. The solution, therefore, is $\mathbf{b}^* = (b^*_{\underline{V}}, b^*_{\overline{V}})$ with $b^*_{\underline{V}} = \underline{v}$ and $b^*_{\overline{V}} = \overline{v}$.

For the first price fair division game (F1), all bids $b_i \geq v_i$ are still weakly dominated. In fact, if $i \neq w(\mathbf{b})$ ($i = \underline{V}, \overline{V}$), then i does not affect the transfer payment by varying her bid in the range from her true value to $b_{w(\mathbf{b})}$. If, instead, $i = w(\mathbf{b})$, then bidding more than the own value only increases the transfer payment $b_{w(\mathbf{b})}/2$ to the other bidder. In case of $b_{w(\mathbf{b})} > b_i + 1$, $i \neq w(\mathbf{b})$, the winner could lower her bid $b_{w(\mathbf{b})}$ and still win. Hence, in equilibrium $b_{w(\mathbf{b})} = b_i + 1$ must hold for $i \neq w(\mathbf{b})$. Furthermore, in case of $b_{\overline{V}} < \underline{v} - 1$, the $\underline{V}$-bidder could gain by bidding $b_{\underline{V}} = \underline{v} - 1$. Thus, the bidding vector $\mathbf{b}^* = (b^*_{\underline{V}}, b^*_{\overline{V}})$ with $b^*_{\underline{V}} = \underline{v} - 1$ and $b^*_{\overline{V}} = \underline{v}$ is the benchmark equilibrium in weakly undominated strategies for F1, which coincides with the solution obtained for A1.

For the second price fair division game (F2), all bids smaller than one's own value are weakly dominated because the winner has to pay the competitor's bid. Rationally anticipating that the $\overline{V}$-bidder will never place a bid lower than $\overline{v}$, the $\underline{V}$-bidder should choose $b_{\underline{V}} = \overline{v} - 1$ so as to increase her monetary compensation. Therefore, the bidding vector $\mathbf{b}^* = (b^*_{\underline{V}}, b^*_{\overline{V}})$ with $b^*_{\underline{V}} = \overline{v} - 1$ and $b^*_{\overline{V}} = \overline{v}$ is the benchmark equilibrium in weakly undominated strategies for F2.

Table 1 summarizes the equilibrium bids b^*_i ($i = \underline{V}, \overline{V}$), equilibrium price p^*, and equilibrium payoffs π^*_i of the four game types, separately for the $\underline{V}$-bidder and the $\overline{V}$-bidder.

The fact that A1 and A2 yield the same equilibrium price and payoffs rep-

Table 1: Equilibrium bids b_i^*, price p^*, and payoffs π_i^* for the four game types, separately for $i = \underline{V}$ and $i = \overline{V}$.

Game type	$b_{\underline{V}}^*$	$b_{\overline{V}}^*$	p^*	$\pi_{\underline{V}}^*$	$\pi_{\overline{V}}^*$
A1	$\underline{v} - 1$	$\underline{v}$	$\underline{v}$	0	$\overline{v} - \underline{v}$
A2	$\underline{v}$	$\overline{v}$	$\underline{v}$	0	$\overline{v} - \underline{v}$
F1	$\underline{v} - 1$	$\underline{v}$	$\underline{v}$	$\frac{\underline{v}}{2}$	$\overline{v} - \frac{\underline{v}}{2}$
F2	$\overline{v} - 1$	$\overline{v}$	$\overline{v} - 1$	$\frac{\overline{v}-1}{2}$	$\frac{\overline{v}+1}{2}$

resents an equivalence result, which is usually established for auctions with a priori symmetric incomplete information about the bidders' true valuations (see, e.g., Wolfstetter, 1996). Moreover, notice that only for F2 the equilibrium payoffs of the two bidders are rather equal; for all other game types the $\overline{V}$-bidder collects, in equilibrium, $\overline{v} - \underline{v}$ more than the $\underline{V}$-bidder.

4. Other-regarding concerns in bidding behavior

We focus on two types of other-regarding concerns: equality and efficiency seeking. The solution behavior allows for nearly equality of payoffs only in F2, where the equilibrium payoffs of the two bidders differ marginally. In A1 and F1 more equitable payoffs would require the $\overline{V}$-bidder to deviate from her equilibrium choice by bidding above $\underline{v}$. Conversely, in A2 the $\underline{V}$-bidder should bid above $b_{\underline{V}}^* = \underline{v}$. Thus equality seeking can be detected via

$$b_{\overline{V}} - b_{\overline{V}}^* = b_{\overline{V}} - \underline{v} > 0 \qquad \text{for A1 and F1}$$

$$b_{\underline{V}} - b_{\underline{V}}^* = b_{\underline{V}} - \underline{v} > 0 \qquad \text{for A2.}$$

The hypothesis that inequality aversion is more moderate in A1 (the procedurally fair institution) than in A2 will be tested by comparing the $b_{\overline{V}} - \underline{v}$-distribution in A1 with the $b_{\underline{V}} - \underline{v}$-distribution in A2. A similar comparison for F1 and F2 is problematic because bidding more than $\underline{v}$ is what the benchmark solution recommends for $\overline{V}$ in F2.

As to efficiency (measured by the sum of individual payoffs), it requires that the winner should always be the $\overline{V}$-bidder, and that the $\underline{V}$-bidder should lower her bid in A2. As in equilibrium the $\overline{V}$-bidder is always the winner, we test whether, compared to A2 and F2, A1 and F1 render the $\overline{V}$-bidder less often the winner. Furthermore, we test whether the observed price is lower in A2 than in A1, and whether the price distributions in F1 and F2 do not differ significantly due to the missing efficiency aspect of the price.

5. Experimental design

In the experiment we set $\underline{v} = 50$, and $\overline{v} = 100$. These values were denoted in ECUs (Experimental Currency Unit). Bids could be any integer number between 30 and 120 ECUs.

Within a session, participants were matched in pairs and played each game type exactly once (i.e., the four games were run in a within-subject design). The two members of a pair were assigned their value (either 50 or 100) at the beginning and kept the same value for all four games. The number of bidders involved in each game ($n = 2$) as well as their values were known by all. We implemented a so-called "perfect stranger" design which ensured that no subject ever met another subject more than once.

Each of the four games was presented separately in a different part of the experiment. Instructions (reproduced in the appendix) were distributed and read aloud in each of the four parts, and participants had the chance to go through control questions and four practice rounds. Once the experimenter had ensured that everyone had understood the game, subjects submitted their bids. Only when all participants had made their decisions in one game, the instructions for the following game were distributed. Subjects did not receive any feedback or payment until the end of the experimental session. At the end of the session, the payoffs obtained in each part were summed up and participants received in private their accumulated earnings.

We implemented four different sequences in which the games were played. Because of the similarity of the games, we always had the two auctions and the two fair division games played in couple. Moreover, we wanted each of the four games played at the beginning of the sequence because initial play (uncontaminated by other features) may be important. Thus, we implemented the following sequences: A1 A2 F1 F2, A2 A1 F2 F1, F1 F2 A1 A2, and F2 F1 A2 A1. This is only a small subset of the 24 possible sequencing variants, but to run sufficiently many repetitions of all variants does not appear to be feasible.

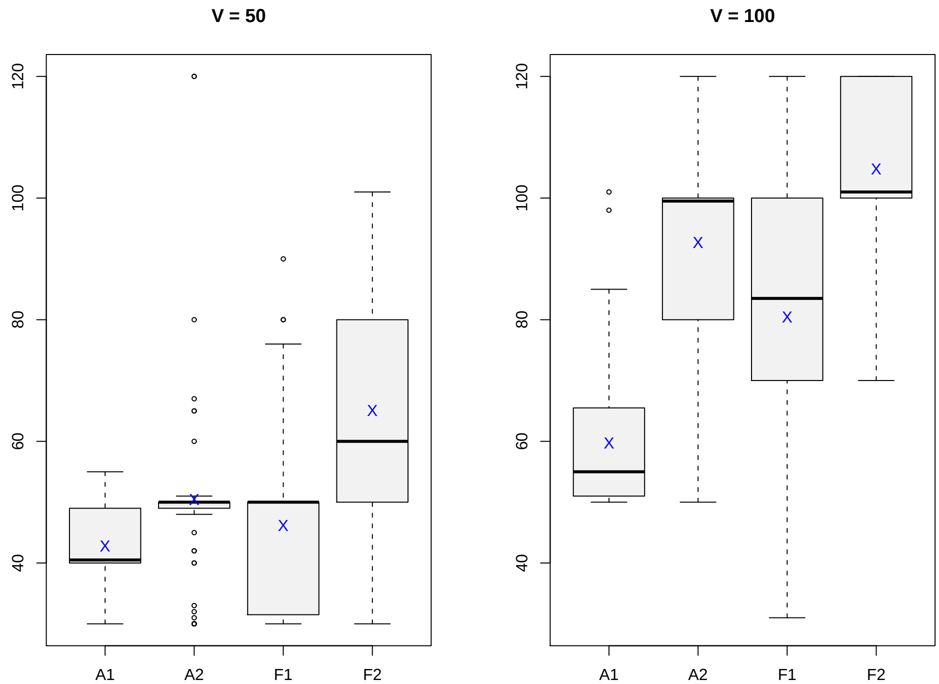
The experiment was programmed in z-Tree (Fischbacher, 2007) and conducted in the experimental laboratory of the Max Planck Institute of Economics (Jena, Germany). The subjects were undergraduate students from the Friedrich-Schiller University of Jena. They were recruited using the ORSEE software (Greiner, 2004). Upon entering the laboratory, the subjects were randomly assigned to visually isolated computer terminals.

We ran one session per sequence. Each session involved 32 participants, matched in pairs. We therefore have 64 $\underline{V}$-bidders and 64 $\overline{V}$-bidders for each game type. Sessions lasted about 90 minutes and the average earnings were €19.03, inclusive of a €5.00 show-up fee.

6. Results

A series of Wilcoxon rank sum tests and Kolmogorov-Smirnov tests do not reveal any significant difference among the four sequences in which the games were played ($p > 0.105$ always). We can therefore pool the data. Figure 1 displays box plots of the individual bids for each game type, separately for the $\underline{V}$-bidder and the $\overline{V}$-bidder (in the figure "**X**" represents the average of the

Figure 1: Box plots of the individual bids for the four game types



distribution).

6.1. *Truthful bidding*

Let us first compare the observed bids with the bidders' true value so as to assess whether procedural fairness affects the proportion of truthful bids. In A1 and F1, undominatedness excludes overbidding with respect to the true value, while in F2 underbidding with respect to the true value is weakly dominated. Only in A2 truthful bidding is uniquely undominated. Therefore, according to the concept of weak dominance, we expect that subjects would, on average, (i) never bid above their true value under the first price rule, whatever the game type (A1 and F1), (ii) never bid below their true value in F2, and (iii) bid truthfully in A2.

Table 2 shows the actual average relative deviations from truthful bidding in each of the four game types, separately for the $\underline{V}$-bidder and the $\overline{V}$-bidder. The observed deviations have the predicted sign, indicating that subjects avoid,

Table 2: Relative observed differences between average bids and true values

Game type	$(b_{\underline{V}} - 50)/50$	$(b_{\overline{V}} - 100)/100$
A1	−0.144	−0.402
A2	0.009	−0.073
F1	−0.076	−0.195
F2	0.302	0.048

on average, weakly dominated choices. Exact Wilcoxon signed-rank tests of the null hypothesis that the central tendency of the bid distribution does not differ from the true value indicate that only $\underline{V}$-bidders bid truthfully in A2 ($p = 0.218$; all other ps do not exceed 0.014). Furthermore, bids are more distant from the true value in A1 than in A2, and in F1 than in F2. Specifically, the relative differences between bids and true values are significantly more negative for A1 (F1) than for A2 (F2) ($p < 0.001$ always; Wilcoxon signed-rank tests comparing $(b_i - v_i)/v_i$ in A1 and A2, and in F1 and F2). Thus, the procedurally fair pricing rule is less consistent with truthful bidding compared to the unfair one. The conjecture that procedural fairness crowds in truthful bidding cannot be confirmed.

6.2. Benchmark bidding

Does procedural fairness "crowd in" solution behavior? Table 3 reports the average relative difference, in absolute value, between the individual bids and the equilibrium bid.[3] Bids are in line with the benchmark in A2 and F1 for the $\underline{V}$-bidder ($p = 0.218$ and 0.196, respectively). The most dramatic deviations from the benchmark are found for the $\underline{V}$-bidder in F2 and the $\overline{V}$-bidder in F1.

In 3 out of 4 comparisons, the first price rule induces lower average deviations from the benchmark than the second price rule. However, according to a Wilcoxon signed-rank test, the deviations are not statistically different when

[3]For each game and bidder type, we average over the difference in absolute value between the individual bid and the benchmark bid.

Table 3: Relative observed average deviations from the equilibrium benchmark

Game type	$\lvert b_{\underline{V}} - b^*_{\underline{V}} \rvert/50$	$\lvert b_{\overline{V}} - b^*_{\overline{V}} \rvert/100$
A1	0.135	0.196
A2	0.137	0.264
F1	0.199	0.658
F2	0.681	0.207

comparing A1 and A2 ($p = 0.337$ for $\overline{V}$; $p = 0.089$ for $\underline{V}$). $\underline{V}$-bidders deviate significantly less from $b^*_{\underline{V}}$ in F1 than in F2, whereas the opposite holds for $\overline{V}$-bidder (both p-values < 0.001). Therefore, except for the $\overline{V}$-bidders in the fair division games, procedural fairness induces more equilibrium behavior, although not always in a significant way. The crowding in of rational benchmark behavior can only be qualitatively and to some extent confirmed.

6.3. Testing for other-regarding concerns

To assess the relevance of the price rule for equality seeking behavior we compare $\frac{b_{\overline{V}} - \overline{v}}{\overline{v}}$ in A1 with $\frac{b_{\underline{V}} - \underline{v}}{\underline{v}}$ in A2. The former difference is a standardized measure of how much of her margin bidder $\overline{V}$ is ready to sacrifice to reduce inequality favoring herself. The latter difference is a standardized measure of how much of $\overline{V}$'s margin bidder $\underline{V}$ is ready to sacrifice to reduce inequality that is to $\underline{V}$'s disadvantage. Obviously, A1 is much more demanding in terms of equality seeking than A2 because $\overline{V}$ must accept a personal cost in order to render her payoff more equal to $\underline{V}$'s payoff.

The average $\frac{b_{\overline{V}} - \overline{v}}{\overline{v}}$ in A1 equals 0.098, while the average $\frac{b_{\underline{V}} - \underline{v}}{\underline{v}}$ in A2 equals 0.009. The two distributions are significantly different according to a Wilcoxon rank sum test ($p < 0.001$). Thus, the procedurally fair first price rule seems to induce more equality seeking than the second price rule.

A first measure of the effects of alternative pricing rules on efficiency can be obtained by looking at how often the $\overline{V}$-bidder is the winner in each game type.

We find that $\overline{V}$ wins 98.4% of the times in A1 and 93.8% of the times in A2. In the fair division games, $\overline{V}$ wins less often under the first price rule (89.1% in F1 vs. 96.9% in F2). A Fisher's exact test shows that alternative price rules do not differ significantly in the number of winners ($p = 0.365$ for A1 vs. A2; $p = 0.164$ for F1 vs. F2).

As to the price paid by the winners, the average price is higher in A1 than in A2 (59.875 vs. 49.078). This questions the equivalence result for symmetric private values auctions (for a survey see Kagel, 1995). The first price rule induces a higher average price also in the fair division games (81.547 in F1 vs. 65.0 in F2).[4]

7. Conclusions

Like in constitutional design (which should promote equal voting rights and equal chances of promotion) and sport contests (where the ranking rules should not arbitrarily favor one athlete or team), also in market design one ought to meet our requirements of procedural fairness. In this paper, we have defined procedural fairness rigorously by providing an axiomatic characterization of fair bidding rules.

More specifically, we have imposed two axioms (envy-freeness of net trades and equal profits according to bids) and referred to bidding rules satisfying both axioms as procedurally fair. We have then considered rules that violate only one axiom, namely the axiom of equal stated profits. This can be justified by the fact that equality seeking (as postulated by equity theory; Homans, 1961) or inequality aversion (Bolton, 1991; Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000) is often claimed to be a strong and purely consequentialistic type of other-regarding concerns.

We were interested in exploring whether, compared to rules that do not

[4]Wilcoxon rank sum tests show that the differences are statistically significant for both the auctions and the fair division games ($p < 0.001$ for both comparisons).

respect the axiom of equal stated profits, procedurally fair rules (i) crowds in more rational bidding, and (ii) mitigates other-regarding concerns. Overall, we could not convincingly confirm either (i) or (ii). Informing participants about the procedural fairness of the different pricing rules, before allowing them to endogenously choose one, may yield stronger effects. This however will have to be explored by future research. So far, we can only conclude that participants do not seem to react very sensitively to the removal of one aspect of procedural fairness, although procedurally fair rules induce more rational benchmark behavior.

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Appendix: Experimental instructions

This appendix reports the instructions (originally in German) that we used for the sequence A1 A2 F1 F2. The instructions for the other sequences were adapted accordingly.

Welcome! You are about to participate in an experiment funded by the Max Planck Institute of Economics. Please switch off your mobile and remain quiet. It is strictly forbidden to talk to the other participants. Whenever you have a question, please raise your hand and one of the experimenters will come to your aid.

You will receive €5.00 for having shown up on time. Beyond this you can earn more money. There is also a small possibility that you end up with a loss. The show-up fee and any additional amounts of money you may earn will be paid to you in cash at the end of the experiment. Payments are carried out privately, i.e., with the others unaware of the extent of your earnings. During the experiment we shall speak of ECUs (Experimental Currency Unit) rather than euros. The conversion rate between them is 10 ECUs = 1 euro.

The experiment consists of four parts. The instructions for the first part follow on this page. The instructions for the second, third and fourth part will be distributed after all participants have completed the first, second and third part, respectively.

DETAILED INFORMATION ON THE FIRST PART

You will be placed in a group of two people (a pair). You and the other person in your pair will take part in an auction in which you can purchase a fictitious object that will be resold to the experimenters.

For both you and the other person in your pair the reselling value of the object being auctioned can be either 50 ECUs or 100 ECUs. With 50% probability your private reselling value will be 50 ECUs and the private reselling value of the other bidder in your pair will be 100 ECUs, and with 50% probability your private reselling value will be 100 ECUs and the private reselling value of the other bidder in your pair will be 50 ECUs. You will learn your own and the other's reselling value at the beginning of the experiment.

Your decision

After learning your individual reselling value, you will have to place a bid for the object being auctioned. Whatever your private value (50 or 100 ECUs), your bid can be any integer number between 30 ECUs and 120 ECUs (i.e., 30, 31, 32, . . ., 118, 119, 120).

Your experimental profit

The bidder with the highest bid will buy the object and pay a price equal to the own bid. Then he/she will sell the object to the experimenters and will receive his/her own reselling value. The price paid by the buyer will be collected by the experimenters. Thus, the profit of the buyer is:

$$\textit{Profit of the buyer} = \textit{own private reselling value} - \textit{own bid.}$$

The other bidder (who does not buy the object) does not pay anything and does not receive the object. Thus, his/her profit is zero:

$$\textit{Profit of the non-buyer} = \textit{0.}$$

In case of a tie (i.e., two equal bids), a random draw will determine the buyer.

Note that if you are the buyer and your bid is higher than your private reselling value, then your profit is negative, i.e. you can suffer a loss. Suppose, for example, that your own reselling value is 100 ECUs. If you bid 110 ECUs and the other person in your pair bids 105 ECUs, you buy the object (because $110 > 105$) and pay 110 ECUs. Your profit would then be $100 - 110 = -10$.

The information you receive

You will be informed about both whether or not you are the buyer and your first part's profit at the end of today's session (i.e., after the fourth part).

Your final payoff

At the end of the experiment, your profits from the four parts will be added up and the resulting sum will be converted to euros. In case of negative cumulative profits, the show-up fee will cover you for losses not greater than €5.00 (= 50 ECUs). If your losses exceed the show-up fee, you can decide between paying the losses from your own pocket and completing an additional task at the end of the experiment. This additional task consists of searching and counting a specific letter in a lengthy text with several sentences. Each correctly completed sentence will compensate you for 1 euro. This task serves only to repay losses and not to earn extra money.

Before the experiment starts, you will have to answer some control questions to ensure your understanding of the rules of the first part of the experiment. Once everybody has answered all questions correctly, four practice rounds will be held so that you may familiarize yourself with the dynamics of the experiment. During these rounds, you will not be matched with a person in this room, but the computer will choose the other's decisions from randomly generated values. The result of these rounds will NOT be relevant for your final payoff.

Please remain quietly seated during the whole experiment. If you have any questions, please raise your hand now. When you have finished reading the instructions for this part of the experiment and if there are no questions, please click "ok" on your computer screen.

DETAILED INFORMATION ON THE SECOND PART

In this second part you will face a similar situation as in the first part. You will be one of two bidders in an auction in which a fictitious object is for sale. Your private reselling value and the private reselling value of the other bidder in your pair will be the same as in the first part. You and the other person in your pair will have to place a bid for the object being auctioned. Whatever your private value, your bid can be any integer number between 30 ECUs and 120 ECUs. The highest bidder will buy the object. The price paid by the buyer will be collected by the experimenters. In case of a tie, a random draw will determine the buyer.

Main differences with respect to the first part

1. You will be matched with a different person.
2. The buyer must pay a price equal to the bid of the other person in his/her pair.
   Thus the profit of the buyer is now:

   Profit of the buyer = own private reselling value − other's bid.

   The profit of the non-buyer is zero, as before.

Even in this second part, if you are the buyer, you can suffer a loss. Suppose, for example, that your own reselling value is 100 ECUs. If you bid 110 ECUs and the other person in your pair bids 105 ECUs, you buy the object (because $110 > 105$) and pay 105 ECUs. Your profit would then be $100 - 105 = -5$.

Before the second part starts, you will have to answer some control questions and then go through four practice rounds so that you may familiarize yourself with the dynamics of this part. As before, during the practice rounds, the computer will determine randomly the other's decisions and the result of these rounds will NOT be relevant for your final payoff.

DETAILED INFORMATION ON THE THIRD PART

In this third part you will face a similar situation as in the previous parts. You will be one of two bidders in an auction in which a fictitious object is for sale. Your private reselling value and the private reselling value of the other bidder in your pair will be the same as in the first and second part. You and the other person in your pair will have to place a bid for the object being auctioned. Whatever your private value, your bid can be any integer number between 30 ECUs and 120 ECUs. The highest bidder will buy the object. In case of a tie, a random draw will determine the buyer.

Main differences with respect to the second part

1. You will be matched with a different person (with whom you have never interacted).
2. The buyer must pay a price equal to his/her own bid (as in the first part).
3. The price paid by the buyer will NOT be collected by the experimenters, but equally divided between the bidders. Thus the profit of the buyer is now:

$$\textit{Profit of the buyer} = \textit{own private reselling value} - \textit{own bid} + \tfrac{1}{2}\ \textit{own bid} =$$
$$= \textit{own private reselling value} - \tfrac{1}{2}\ \textit{own bid.}$$

4. The other bidder (who does not buy the object) does not pay anything, and does not receive the object. But he/she receives half the price paid by the buyer (i.e. half the other's bid). Thus, his/her profit is now:

$$\textit{Profit of the non-buyer} = \tfrac{1}{2}\ \textit{other's bid.}$$

Even in this part, if you are the buyer, you can suffer a loss. Suppose, for example, that your own reselling value is 50 ECUs. If you bid 110 ECUs and the other person in your pair bids 105 ECUs, you buy the object (because $110 > 105$), pay 110 ECUs, and get back $\frac{1}{2}110 = 55$. Your profit would then be $50 - 55 = -5$.

Before the third part starts, you will have to answer some control questions and then go through four practice rounds so that you may familiarize yourself with the dynamics of this part. As before, during the practice rounds, the computer will determine randomly the other's decisions and the result of these rounds will NOT be relevant for your final payoff.

DETAILED INFORMATION ON THE FOURTH PART

In this fourth part you will face a similar situation as in the third part. You will be one of two bidders in an auction in which a fictitious object is for sale. Your private reselling value and the private reselling value of the other bidder in your pair will be the same as in the previous parts. You and the other person in your pair will have to place a bid for the object being auctioned. Whatever your private value, your bid can be any integer number between 30 ECUs and 120 ECUs. The highest bidder will buy the object. The price paid by the buyer will be equally divided between bidders. In case of a tie, a random draw will determine the buyer.

Main differences with respect to the third part

1. You will be matched with a different person (with whom you have never interacted).
2. The buyer must pay a price equal to the bid of the other person in his/her pair.
3. Since the price paid by the buyer (i.e. the other's bid) will be equally divided between the bidders, the profit of the buyer is:

   $$\textit{Profit of the buyer} = \textit{own private reselling value} - \textit{other's bid} + \tfrac{1}{2}\ \textit{other's bid} =$$
   $$= \textit{own private reselling value} - \tfrac{1}{2}\ \textit{other's bid}.$$

4. The other bidder (who does not buy the object) receives half the price paid by the buyer, which now is half his/her own bid. Thus, his/her profit is:

   $$\textit{Profit of the non-buyer} = \tfrac{1}{2}\ \textit{own bid}.$$

Even in this part, if you are the buyer, you can suffer a loss. Suppose, for example, that your own reselling value is 50 ECUs. If you bid 110 ECUs and the other person in your pair bids 105 ECUs, you buy the object (because $110 > 105$), pay 105 ECUs, and get back $\frac{1}{2}105 = 52.5$. Your profit would then be $50 - 52.5 = -2.5$.

Before the fourth part starts, you will have to answer some control questions and then go through four practice rounds so that you may familiarize yourself with the dynamics of this part. As before, during the practice rounds, the computer will determine randomly the other's decisions and the result of these rounds will NOT be relevant for your final payoff.