Experimental Investigation of Overbidding in the All-Pay Auction

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Abstract

Bidding behavior in all-pay auctions is well documented as deviating from the Nash predictions. In particular, there is pervasive and significant overbidding not only in terms of the aggregate groups bids being greater than the value of the prize, but also by individuals placing bids that guarantee them to earn negative profit. In this paper, we conduct a series of experiments in order to attempt to provide behavioral explanations for these bidding strategies. We find that individual agents are not especially strategically motivated, but rather we believe that non-monetary incentives play a significant role. Another critical factor in overbidding is the framing of the earnings. If earnings are presented in a positive manner instead of negatively as in the standard all-pay auction framework, then aggregate overdissipation can be eliminated in the long run.

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1. Introduction

The classic rent seeking scenario presented by Tullock (1980) is such that the probability of winning the prize is an increasing function of one's own effort, and the all-pay auction (henceforth APA) is the limiting case in which the prize is always awarded to the participant who exerts the most effort. There are many economic situations characterized by the APA. Some examples of these are lobbyists' attempts to gain power with political groups or win monopoly licenses, multiple firms engaging in a research and development race to be the first to release a new product, concert or sporting event tickets being allocated to those that wait in line the longest, etc… In situations like these, participants can put forth quite costly effort, and the losers are not reimbursed these real expenditures. These welfare losses can be quite extensive. Krueger (1974) estimates that the losses associated with rent seeking behavior were 7.3% of India's GNP in 1964 and 15% of Turkey's GNP in 1968.

Most of the experimental studies analyzing the APA have focused on auctions with complete information (Potters et al., 1998; Davis and Reilly, 1998; Gneezy and Smorodinsky, 2001). In these studies, it has been consistently shown that agents behave more aggressively than predicted by the Nash equilibrium. Therefore, there is typically an aggregate overdissipation of the rents available in the auction. That is, the sum of all participants' bids is greater than the value of the unit being auctioned.

Davis and Reilly (1998) conduct a series of experiments to test the theoretical predictions of the complete information APA characterized by Baye et al. (1996). They find a pervasive and significant aggregate overdissipation of rents. Moreover, they show that aggregate overbidding decreases but does not disappear with experience.[1] Davis and Reilly conjecture that this phenomenon cannot be explained by risk aversion, which is traditionally used to justify overbidding in the winner-pay auction[2]. Anderson et al. (1998) develop a theoretical model in which bidding behavior is subject to error, and conjecture that overbidding in APA occurs due to the bounded rationality of subjects. Their model is consistent with the data of Davis and Reilly. An implication of the Anderson et al. model is that overbidding should increase with the size of the bidders' group. To directly test this theory, Gneezy and Smorodinsky (2001) conduct a separate

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[1] Participants were considered experienced if they had participated in at least one session, but in a different cohort and in many cases in a different design.

[2] In particular, the first price private value winner-pay auction (Cox et al., 1988)

study in which they vary group size (four, six, eight, or twelve participants). Their findings were consistent with Davis and Reilly in that they found a systematic aggregate overdissipation of rents. They also found that the overdissipation was independent of the group size in later periods. To the best of our knowledge, the only study where overbidding is not significant is provided by Potters, et al. (1998).[3] Their design has three main difference compared to previous studies that may attribute to this result. First, the Nash equilibrium is unique for a group of two, while there is a plethora of equilibria for any group size larger than two. Second, their group size is limited to two, which may increase the ability of participants to collude. Lastly, the endowment that subjects receive in every period only slightly exceeds the value of the prize, and thus may bias individual and aggregate dissipation to lower levels.

It is also important to underline that while the main focus of the above cited experimental research is on the aggregate overdissipation, the data of all these studies exhibit individual overdissipation, in which the bid of a single participant is greater than the value of the unit being auctioned.[4] This result is theoretically impossible, even probabilistically, since players can always insure a zero payoff by bidding zero (Baye et al., 1999). We conjecture that individual overdissipation might be due to strategic behavior, i.e. reputation effects. In other words, some subjects are willing to incur a small loss in the current period with probability one in view of expected future earnings. More specifically, a strategic participant places bids greater than the value of the good in early periods in order to signal to their opponents that they are interacting with an 'irrational' bidder, thereby 'scaring' them into bidding very low in future periods. The strategic participant can then win the future auction(s) with a relatively low bid and receive a large payout. In order for a participant to behave strategically, there must be repeated interaction in a repeated APA. Therefore in this study, the subjects' matching protocol is one of our treatment variables. In particular, we hold the makeup of the groups fixed in some sessions (Partner matching protocol), while in others the composition is changed

[3] Their study consisted of 30 periods and aggregate overdissipation was eliminated by end of the session.
[4] In previous experiments with four participants under Partner matching (Davis and Reilly, 1998; Gneezy and Smorodinsky, 2001) the incidence of individual overbidding is approximately 3% while Potters, et al. (1998) observed approximately 1% in the first 20 periods and 0% in the last 10 periods.

randomly in every period (Stranger matching protocol).[5] A higher incidence of individual overdissipation under Partner than under Stranger matching would suggest that the bidding behavior depends on repeated interaction. This conjecture is formalized in the following hypothesis:

> ***Hypothesis 1:*** Individual overdissipation and average aggregate overdissipation are more prevalent under a partner matching protocol than under a stranger matching protocol.

One of the challenges of conducting APA with the typical design used in almost all previous studies lies in the fact that in expectation each player earns zero-profit. Under the standard APA design in which participants are only allowed to submit non-negative bids, subjects may not feel that it is appropriate or expected of them to bid zero since this is equivalent to doing nothing, i.e. by bidding zero subjects keep their earnings unchanged.[6] Therefore, we conjecture that a standard symmetric design with a non-negative bidding space is biased against bidding zero. To help illustrate our point, consider this situation from the prospective of an experiment subject. They have been recruited for participation in an APA and trained on the auction procedures (read the instructions, completed quizzes and participated in a practice period). After being provided all this information on the auction process, the subject may feel as though it is expected of them, and thus their duty, to bid actively within the auction. That is, to use the knowledge that has been very carefully and thoroughly provided to them instead of bidding zero, which simply preserves their initial endowment. This factor may make zero bids less likely to occur in experiments than predicted theoretically.[7]

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[5] To our knowledge, Potters et al (1998) is the only other study to implement a stranger matching protocol.

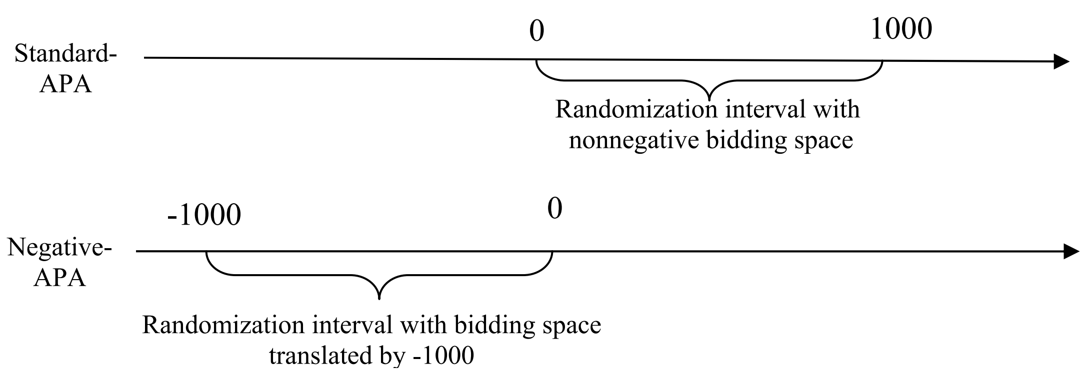
[6] One can argue that it is not true for the case when all members of the group submit a zero bid. Note that this case is neither possible in equilibrium (even probabilistically), nor observed experimentally in groups of four players. In our experiment we auctioned off 1440 prizes for the groups of four people using the standard design (with zero as the lowest possible bid), and it was never the case that all four players submitted zero bids.

[7] Lei, et al. (2001) have a similar conjecture regarding participation and non-participation of subjects in financial trading, where subjects make unprofitable trades rather than doing nothing in financial market experiments.

Hypothesis 2: Standard design of symmetric APA experiments in which zero is the lowest possible bid is biased against bidding zero.

In order to test *Hypothesis 2*, we translated the bidding space of the standard-APA by -1000. In this case, the strategy space starts at -1000 (rather than at 0). This is equivalent to rescaling the game by a constant. The expected payoff to each player is 1000 and the randomization interval is translated by -1000, i.e. from [0, 1000] to [-1000, 0], as illustrated by figure 1. This game is referred to as the "negative-APA." The initial endowments are adjusted accordingly, so that the expected payoffs are kept the same across treatments. A summary of predictions for each auction is presented in table 1. *Hypothesis 2* will be supported if subjects in the negative-APA place -1000 bids more often than the subjects in the standard-APA place zero bids.

Figure 1: Equilibrium Predictions for Games under the Standard-APA and Negative-APA



If *Hypothesis 2* is supported and thus the standard-APA design is biased against zero bids, it then strictly follows that the standard-APA design is also biased in favor of strictly positive bids, and therefore potentially biased in favor of aggregate overdissipation. This is more precisely stated in the following hypothesis:

***Hypothesis 3*: Standard design of symmetric all-pay auction experiments in which zero is the lowest possible bid is biased in favor of aggregate overdissipation.

In order to test this hypothesis, we will compare the incidence of aggregate overdissipation in the standard-APA against the negative-APA. *Hypothesis 3* will be supported if the frequency of aggregate overdissipation is lower in negative-APA than in the standard-APA game.

Lastly, we conjecture that that confusion by subjects is a significant factor attributing to deviations from Nash predictions. All previous studies have only used inexperienced subjects in experiments of 30 periods or less. Given the complexity of calculating the Nash equilibrium mixed strategies, learning might take longer than participating in a short session of 15 or even 30 periods. Therefore, inexperience may be a significant contributing factor to the observed systematic deviations from Nash predictions in previous studies. If subjects participate in a longer APA in order to acquire a sufficient level of experience, group overbidding may be eliminated. Therefore, bounded rationality would not explain the observed deviations from Nash equilibrium.

> ***Hypothesis 4:*** Within session learning decreases the incidence of aggregate overdissipation and aggregate dissipation converges to the Nash-predicted level over time.

To test this hypothesis, we constructed all our treatments to have a time horizon of 60 periods, which is at least twice as long as any previous study that we are aware of. Lower levels of aggregate dissipation in later periods will provide evidence in support of *Hypothesis 4.*

The rest of the paper is organized in the following manner. Section 2 provides the experimental design. Section 3 describes the experimental results and concluding remarks are presented in section 4.

2. The Experiment

The experiment consisted of nine sessions conducted at the University of Canterbury, Christchurch, New Zealand in 2004. A total of 144 subjects were recruited from undergraduate economics and mathematics courses. Although some of the subjects may have participated in previous economics experiments, none had any experience in market experiments. Each subject participated in only a single session of the study. The experiment was computerized and used the Ztree software package, developed at the University of Zurich, Institute for Empirical Research in Economics.[8] The currency used for decision making within the experiment was called francs. Subjects' earnings were paid in New Zealand dollars at the end of the experiment according to a predetermined and publicly known conversion rate between francs and dollars. The conversion rate differed between sessions, but was always identical for all subjects within a given session. On average, a session lasted 90 minutes including initial instruction period and the payment of subjects. Subjects earned an average of $17.56NZ.[9]

Table 1: Summary of Treatments

Session Number	Treatment	Matching Protocol	Endowment	Bidding Space	Theoretical Predictions	
					Randomization Interval	Expected per period earnings
1	S	Strangers	65,000	$[0,\infty)$	[0,1000]	0
2	S	Strangers	65,000	$[0,\infty)$	[0,1000]	0
3	S	Strangers	65,000	$[0,\infty)$	[0,1000]	0
4	P	Partners	65,000	$[0,\infty)$	[0,1000]	0
5	P	Partners	65,000	$[0,\infty)$	[0,1000]	0
6	P	Partners	65,000	$[0,\infty)$	[0,1000]	0
7	P-neg	Partners	5,000	$[-1000,\infty)$	[-1000,0]	1000
8	P-neg	Partners	5,000	$[-1000,\infty)$	[-1000,0]	1000
9	P-neg	Partners	5,000	$[-1000,\infty)$	[-1000,0]	1000

We focus on a first-price APA with four players and complete information, i.e. auctions in which all bidders' valuations for the unit(s) being sold are common knowledge. The value of the prize is taken to be 1000. Each bidder (i=1,2,3,4) simultaneously submits a sealed bid b_i and the highest bidder gets the prize. In the case

[8] See Fischbacher (1999) for a discussion of the Ztree software package.
[9] The minimum wage in New Zealand was $9.00NZ per hour at the time that the experiments were conducted.

of a tie, the prize is equally shared among the highest bidders. All players must pay their bid. Thus, the payoff to a risk-neutral player *i* in this game is:

$$(0.1) \quad U_i(b_1,...,b_4) = \begin{cases} -b_i & \text{if } \exists\, j \neq i \text{ such that } b_j > b_i, \\ \dfrac{1000}{m} - b_i & \text{if } i \text{ ties for the highest bid with } (m-1) \text{ others}, \\ 1000 - b_i & \text{if } b_i > b_j \quad \forall j \neq i. \end{cases}$$

Under the assumption of non-negative bids, the full characterization of equilibria for this game is provided by Baye et. al (1996). The common features of all equilibria are that at least two players randomize over the interval from 0 to 1000, and that the expected payoff to each player is zero. Consequently, the expected sum of the group bids (aggregate dissipation) is equal to the value of the rent. However, probabilistically this sum might be both below and above the value of the rent (Baye et. al, 1999). We refer to this game as the standard-APA.

The design of the experiment consists of three treatments (P, S and P-neg) and employs two treatment variables (matching protocol and bidding space). The features distinguishing the different treatments are summarized in table 1. In treatments P and P-neg, a Partner matching protocol was implemented in which the computer network separated the subjects into groups, and it was common information that these group assignments remained constant for the entire session. A stranger matching protocol was implemented in treatment S such that subjects were re-matched each period into new groups of four. It was common knowledge that each subject had zero probability of being matched with the same group member for two consecutive periods and a very low probability that they will be matched with the same group member in period $t + 2$.[10] For our second treatment variable, we varied the feasible bidding space. Treatments P and S are the standard-APA in which bidders were only allowed to place non-negative bids. The P-neg treatment is a negative-APA, which as discussed in the previous section, is

[10] Note that our stranger matching protocol differs from random matching in that players are guaranteed that they will never play with the same group for two consecutive periods. Even though our stranger matching protocol does not completely eliminate the possibility for strategic behavior, it does make it much more difficult.

exactly the same as the standard-APA except for the strategy space is translated by -1000. That is, any bid greater than or equal to -1000 was permitted.

At the beginning of each session, the experimenter read the instructions aloud.[11] The subjects were encouraged to follow along with their own copy of the instructions and to ask any questions relating to the interface and rules at any time.[12] There was no communication allowed between subjects at any time during the experiment. All interaction took place via the computer terminal and all decisions were anonymous.

Each session consisted of 60 plays of the same first-price APA. In each session we had four groups of four participants who played the role of bidders. We refer to each play of the auction as a period. The total number of periods in a session and the fact that the rules in each period were identical was common knowledge. In each period, there was a single fictitious good auctioned to each group of four bidders. It was common knowledge that the valuation of the good was identical across all bidders and equal to 1000 francs. In each period, bidders simultaneously placed bids for the single good offered for sale in that period.[13] The bidder with the highest bid won the auction and their earnings equaled the 1000 franc reservation value minus the bid offered for the good.[14]

All bidders had their bid subtracted from their earnings regardless of whether they won the auction or not. In treatments P and S, every bidder with a non-winning bid incurred losses for the period equal to the amount of their bid. In order to cover these potential losses, subjects in treatments P and S received a participation fee of 65000 francs. It was announced at the beginning of the experiment that this money was theirs to keep and any earnings or losses incurred would be added or subtracted from this participation fee.[15] In treatment P-neg, non-strategic rational bids were in the interval [-1000, 0]. Therefore, subtracting a negative bid from their period earnings translated into

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[11] The instructions for each treatment are provided in the appendix.
[12] The experimenter addressed questions privately to ensure that other subjects were not biased by potential normative statements/questions. If the question was beneficial to the entire group, the question was repeated and answered to the group.
[13] In order to approximate a continuous bidding space, bidders were allowed to place bids up to the 4th decimal place.
[14] In the event of a tie for the highest bid, the 1000 francs was split equally among all tied highest bidders.
[15] Given the nature of an all-pay auction, it is possible for a subject to have negative overall earnings. That is, a sum of potential losses each period is greater than the 65000 franc initial endowment. However, this did not occur in any of our sessions.

positive earnings for the period equal to the amount of their bid. If their bid was the highest bid and thus won the auction, then their period earnings equaled their bid plus the 1000 franc reservation value. Under the assumption of non-strategic rational behavior, there should only be positive earnings each period. In order to make the expected payoffs equivalent across treatments, 5000 francs were provided as an initial endowment to participants in the P-neg treatment.

At the end of every period, the subjects were provided with a summary screen that displayed all four group members' bids, their own bid, the highest (winning) bid and their period earnings. This information was available for the current period, but also a history from all previous auctions in the session. To present all four group members' bids on the summary screen, each group member was assigned an identifier of letters A through D. In treatments P and P-neg, the bidder identifiers remained constant for the entire session, and thus it was possible to associate bidding behavior with a particular bidder over time. In treatment S, not only was the group assignments changed every period, but also the ordering of the bidder identifiers. Therefore, it was not possible to trace individual behavior and greatly increased the difficulty of strategic behavior.

3. Experimental results

Figures 2a and 2b compares the incidence of individual overdissipation and aggregate dissipation over time for all three treatments.[16] It is readily apparent from the figures that *Hypothesis 1* is not supported by the data. A partner matching protocol does not provide a higher percentage of individual overdissipation or average aggregate dissipation than a stranger matching protocol in the standard-APA. In fact, five of the six ten-period segments provide a higher level of both types of dissipation in the stranger matching protocol. This is stated more precisely in result 1 below.

Result 1: The incidence of individual overdissipation and average aggregate dissipation are not higher under Partner than under Stranger matching protocol.

[16] Corresponding tables for all figures are provided in the appendix, which present the data for individual sessions as well as the over-treatment means.

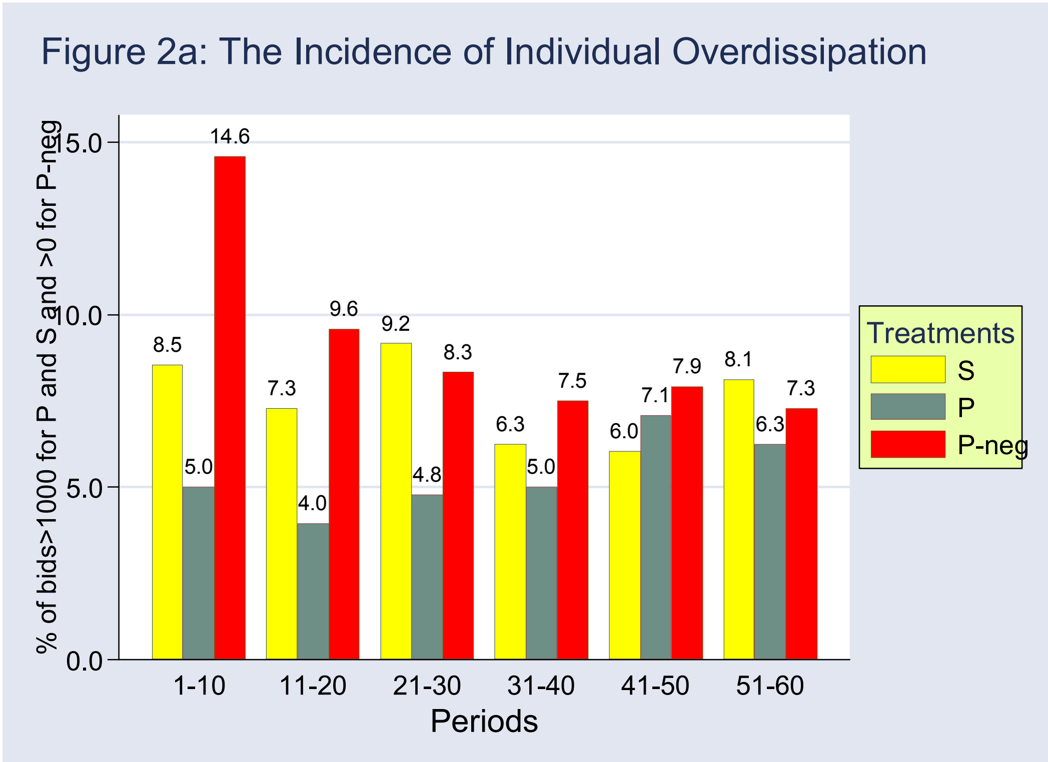
Figure 2a: The Incidence of Individual Overdissipation
% of bids>1000 for P and S and >0 for P-neg
15.0
10.0
5.0
0.0
14.6
8.5
5.0
7.3
4.0
9.6
9.2
4.8
8.3
6.3
5.0
7.5
6.0
7.1
7.9
8.1
6.3
7.3
1-10
11-20
21-30
31-40
41-50
51-60
Periods
Treatments
S
P
P-neg

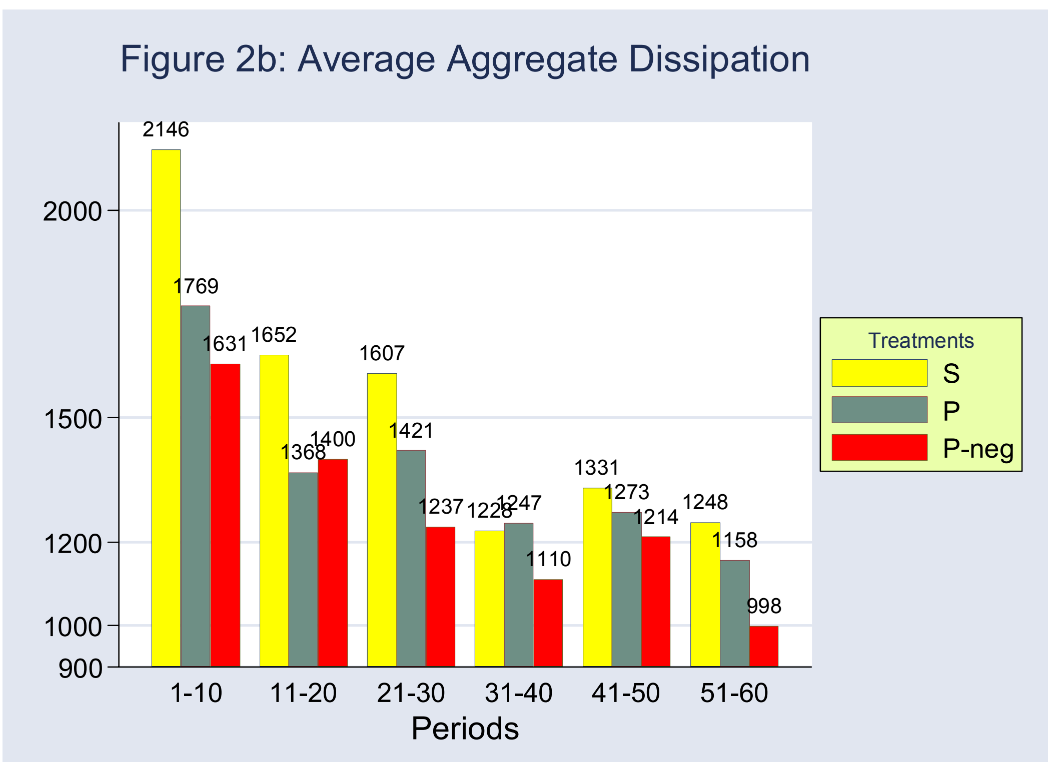
Figure 2b: Average Aggregate Dissipation
2000
1500
1200
1000
900
2146
1769
1631
1652
1368
1400
1607
1421
1237
1228
1247
1110
1331
1273
1214
1248
1158
998
1-10
11-20
21-30
31-40
41-50
51-60
Periods
Treatments
S
P
P-neg

Support for result 1: A Mann-Whitney rank-sum test[17] of the difference between the incidence of individual overdissipation under partner and stranger yields z = -1.01 and is not significant at conventional levels. A rank-sum test of the difference between average aggregate dissipation under partner and stranger also yields an insignificant value of z = -0.9. The negative values of z-statistics indicate that the difference between treatments (though statistically insignificant) is the opposite from what we expected. That is, there is weak evidence that the incidence of individual overdissipation and average aggregate dissipation are *lower* under the partner matching protocol than under stranger. □

Figure 3: The Incidence of Submitting the Lowest Bid
(Zero for P and S, and -1000 for P-neg)

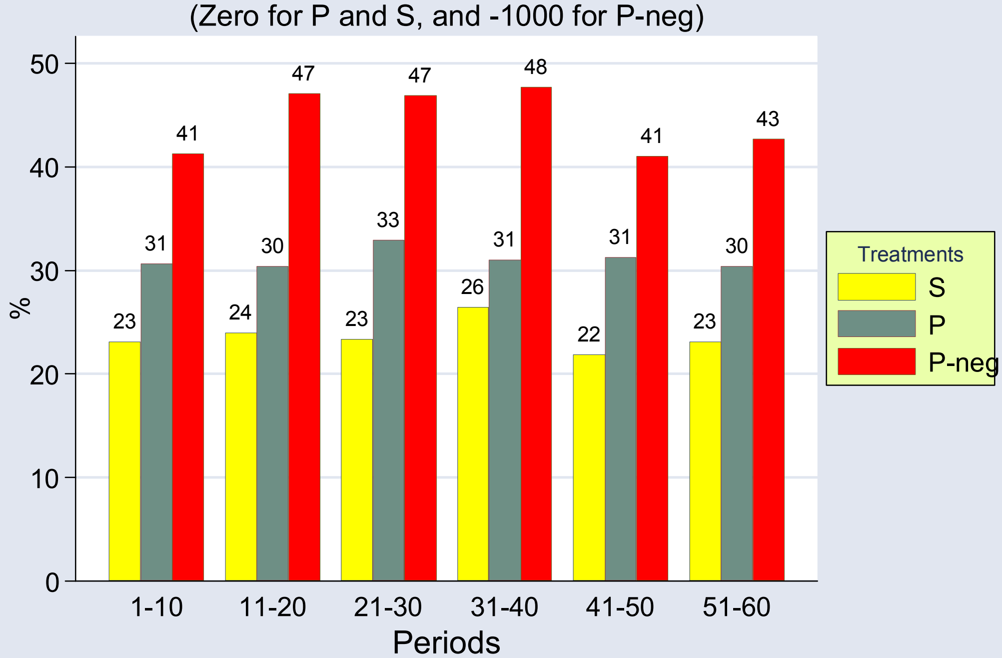

Figure 3 presents statistics concerning the incidence of bidding the lowest possible bid in each treatment. Treatments P and S both employ the standard-APA in which zero is the lowest possible bid and P-neg implements the negative-APA design, which has -1000 as the lowest possible bid. It is clear from figure 3 that Hypothesis 2 is

[17] In all statistical tests reported in this paper the unit of observation is at the group level for the P and P-neg data, and the session for the S data.

supported by the data. The negative-APA provides the highest frequency of the lowest possible bid, which on average is 13% higher in P-neg than P and 20% higher in P-neg than S. The main conclusion we draw from this comparison is stated as Result 2.

Result 2: The standard design of symmetric all-pay auction experiments is biased against bidding zero.

Support for result 2: Table 2 provides the results of Mann-Whitney test comparing P-neg with P and S. From the table it is evident that the incidence of submitting the lowest possible bid is significantly lower in the negative-APA, P-neg, than in the treatments employing the standard-APA design, P and S. There is no significant difference between either of these standard-APA treatments. □

Table 2: Mann-Whitney Test Statistics Comparing the Incidence of Lowest Possible Bid Submission

Treatments / Periods	P-neg vs P z (p-value)	P-neg vs S z (p-value)	P vs S z (p-value)
overall	**3.0 (0.00)**	**2.6 (0.01)**	**1.4 (0.14)**
1-10	**1.9 (0.05)**	**2.2 (0.03)**	**1.5 (0.11)**
11-20	**2.5 (0.01)**	**2.6 (0.01)**	**1.3 (0.19)**
21-30	**2.3 (0.02)**	**2.2 (0.03)**	**1.1 (0.27)**
31-40	**3.0 (0.00)**	**2.2 (0.03)**	**0.7 (0.51)**
41-50	**2.1(0.04)**	**2.2 (0.02)**	**1.3 (0.19)**
51-60	**1.9 (0.05)**	**2.3 (0.02)**	**1.3 (0.19)**

Next we can test whether the bias against bidding zero in the standard-APA is also an attributing factor to aggregate overdissipation with this design. Figure 2b presents the average aggregate dissipation levels across treatments and provides evidence in support of Hypothesis 3. That is, the negative-APA implemented in the P-neg treatment has a lower incidence of average aggregate overdissipation than both treatments employing the standard-APA over the entire time horizon.

Result 3: The negative-APA design has an overall lower level of rent dissipation compared to the standard-APA design.

Support for result 3: Table 3 provides the results of Mann-Whitney test comparing P-neg to P and S. We are able to reject the hypothesis that the median level of aggregate dissipation in the pooled data for the entire time horizon in P-neg is the same as P (significant at $p < 0.1$) and S (significant at $p < 0.05$). □

Table 3: Mann-Whitney Test Statistics Comparing the Levels of Aggregate Dissipation.

Treatments / Periods	P-neg vs P z (p-value)	P-neg vs S z (p-value)
overall	**-1.7 (0.09)**	**-2.0 (0.04)**
1-10	**-0.9 (0.39)**	**-1.7 (0.08)**
11-20	**-0.5 (0.60)**	**-1.4(0.15)**
21-30	**-0.8 (0.45)**	**-1.9 (0.06)**
31-40	**-1.1 (0.27)**	**-1.1 (0.31)**
41-50	**-1.2 (0.23)**	**-1.3 (0.19)**
51-60	**-1.9 (0.06)**	**-1.4 (0.14)**

1. Negative value indicates that the aggregate dissipation is lower in P-neg.

As discussed in the introduction, participants come into the experiment with no previous experience with the auction process, and one might expect that their bidding decisions may significantly change as they gain experience over time. Figure 2b compares the average aggregate dissipation levels for all treatments in each 10 period segment of the experiment. The data exhibits strong support for Hypothesis 4 in that the level of overdissipation decreases over time in all three treatments. This suggests that participants may in fact alter their behavior as they become more familiar with the auction process and gain experience with their bidding strategies.

Result 4: The level of aggregate dissipation decreases with experience in all treatments.

Support for result 4: The results from a Wilcoxon signed-rank tests analyzing the level of average aggregate dissipation for the same group across periods is presented in table 5. For both treatments implementing the partner matching protocol (P and P-neg), the average aggregate level of dissipation is decreasing in all but three of the ten-period comparisons. In treatment P, the level of aggregate dissipation in each of the ten-period segments in the second half of the experiment are significantly lower than in periods 1-10. For P-neg, the first 10 periods have a significantly higher level of aggregate dissipation than any following ten-period segment, and the last ten-period interval is statistically different from all but 4th ten-period segment. □

Table 5: The Effect of Experience on Average Aggregate Dissipation

	Treatment										
	P						P-neg				
Earlier Periods / Later Periods	1-10	11-20	21-30	31-40	41-50		1-10	11-20	21-30	31-40	41-50
11-20	-1.6						-2.0**				
21-30	-1.0	1.1					-2.5**	-1.3			
31-40	-2.2**	-0.8	-1.5				-2.7***	-1.9*	-1.4		
41-50	-2.6***	-1.2	-1.2	0.2			-1.8*	-1.0	0.2	1.6*	
51-60	-2.7***	-1.5	-1.5	-0.6	-1.2		-2.9***	-2**	-1.8*	-0.9	-2.5***

Negative values of z-statistics indicate lower level of aggregate dissipation in "Later periods"
* significant at 10% level
** significant at 5% level
***significant at 1% level

Although the level of average aggregate dissipation decreases in all three treatments, overdissipation is only eliminated under the negative-APA design. In the last

10 periods of P-neg, the average aggregate dissipation level is 998 compared to 1158 in P and 1248 in S.[18]

Result 5: Average aggregate dissipation converges over time to theoretically predicted levels in the P-neg treatment under the negative-APA design.

Support for result 5: In the last ten periods of P-neg, the mean aggregate dissipation level is not significantly different than 1000 ($p < 0.01$). For both treatments implementing the standard-APA, the mean aggregate dissipation levels in the last 10 periods are greater than 1000 at the $p < 0.05$ level. □

Conclusions

This paper contributes to the study of overbidding in common value all-pay auctions with complete information. Provided that overbidding has been observed both at the aggregate level and (more surprisingly) at the individual level[19], we formulate four hypotheses.

Hypothesis 1 conjectures that individual overdissipation might result from the desire to establish the "reputation of the winner". In other words, a subject might believe that by overbidding he could induce his group-mates to place low bids. In this case, he would be willing to incur a current loss in view of future benefits. It is reasonable to expect that the returns to this behavior are higher the longer is the repeated interaction. This is why we address this hypothesis by employing different matching protocols. We would expect individual overdissipation to be more prevalent under a partner matching protocol than under stranger (random) matching. Our findings do not seem to support the reputation hypothesis as formulated. In fact, the incidence of individual overdissipation is higher under the strangers matching protocol. We think that contagion effects, in conjunction with spite motives (also confirmed by after experiment questionnaires) might partially account for this behavior.

[18] In order to make the average aggregate dissipation levels comparable across treatments, we added 1000 to the P-neg values such that all theoretical predictions are mean (X) = 1000.
[19] Individual overbidding consists of placing a bid exceeding the value of the prize, therefore guaranteeing a loss.

The second and third hypotheses deal with the concern that the standard APA design might be biased in the eyes of the subjects. More specifically, in the standard APA design, the lowest possible bid that subjects can place is zero. Hypothesis 2 conjectures that this design is biased in favor of positive bids in the following sense. A subject might be reluctant to place a zero bid since it might make him feel inactive. This hypothesis is reminiscent of the active participation hypothesis formulated by Lei et al (2001) in a different environment. Building on Hypothesis 2, Hypothesis 3 contains the conjecture that a bias toward positive bids might potentially lead to a bias toward aggregate overdissipation.

We tested these hypotheses by framing the APA decision problem in a different manner that does not betray the substance of the game. In particular, we performed a translation of the decision bidding space that allows subjects to place negative bids, and we refer to this game as Negative-APA. Our data suggests that the standard design is indeed biased against placing the lowest bid, and favors aggregate overdissipation. In particular, it is interesting to point out that under Negative-APA aggregate overdissipation is eliminated in the last 10 periods.

This remark raises in its turn another question: does experience matter? That is, as subjects get repeatedly exposed to the game, do we see a decrease in overdissipation? We deal with this issue by allowing for 60 periods, whereas the highest number of periods employed in the existing literature was 30. Our findings suggest that experience is critical to the reduction of aggregate overdissipation. In particular, aggregate overdissipation is significantly reduced in all treatments, and eliminated in the Negative-APA.

On the other hand, the incidence of individual overdissipation does not seem to decline over time. This seems to suggest that utility does not depend only on the monetary rewards, but it includes other arguments as well. In particular, individual overbidding might be observed as a reflection of two desires: the desire to win and the desire to punish. In other words, subjects might overbid since they want to win the auction even though this entails some losses. On the other hand, subjects clearly demonstrate that they are willing to forfeit some of their monetary reward in order to "punish" other members of the group whenever they detect an "unfair" (overly aggressive) behavior. A possible way to disentangle the two effects might consist in making use of a design employing computerized opponents. If overbidding is still observed in this environment then the desire to punish prevails over the desire to win. We think these conjectures are interesting and leave them for further investigation.

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Appendix A

Table 2a: Incidence of Individual Overdissipation under Stranger and Partner Matching.

Periods \ Treatment	S				P				P-neg			
	Session			mean	Session			mean	Session			mean
	1	2	3		4	5	6		7	8	9	
overall	4.4	10.6	7.7	**7.6**	6.2	4.0	6.0	**5.4**	9.8	13.7	9.9	**11.1**
1-10	6.3	18.8	0.6	**8.6**	6.3	0.0	8.8	**5.0**	6.3	19.4	18.1	**14.6**
11-20	3.8	13.1	5.0	**7.3**	8.1	0.0	3.8	**4.0**	6.9	12.5	9.4	**9.6**
21-30	5.6	10.6	11.3	**9.2**	6.9	2.5	5.0	**4.8**	8.1	11.9	5.0	**8.3**
31-40	3.8	5.6	9.4	**6.3**	6.3	3.1	5.6	**5.0**	8.8	9.4	4.4	**7.5**
41-50	2.5	8.1	7.5	**6.0**	5.0	11.3	5.0	**7.1**	10.6	10.0	3.1	**7.9**
51-60	4.4	7.5	12.5	**8.1**	4.4	6.9	7.5	**6.3**	9.4	10.0	2.5	**7.3**

Table 2b: Average Aggregate Dissipation.

Periods \ Treatment	S				P				P-neg			
	Session			mean	Session			mean	Session			mean
	1	2	3		4	5	6		7	8	9	
overall	1453	1522	1631	**1535**	1340	1521	1258	**1373**	1138	1439	1219	**1265**
1-10	1988	2339	2111	**2146**	1774	1714	1820	**1769**	1260	1841	1791	**1631**
11-20	1636	1690	1631	**1652**	1465	1569	1070	**1368**	1107	1535	1559	**1400**
21-30	1756	1477	1588	**1607**	1191	1816	1257	**1421**	1048	1342	1323	**1237**
31-40	1076	1221	1386	**1228**	1125	1618	997	**1247**	1055	1290	986	**1110**
41-50	1132	1417	1444	**1331**	1266	1321	1233	**1273**	1302	1447	891	**1214**
51-60	1127	990	1626	**1248**	1217	1088	1168	**1158**	1054	1176	764	**998**

Table 3: Incidence of Submitting the Lowest Possible Bid (Zero for P and S, and -1000 for P-neg).

Periods \ Treatment	S				P				P-neg			
	Session			mean	Session			mean	Session			mean
	1	2	3		4	5	6		7	8	9	
overall	26	27	18	**24**	33	31	30	**31**	41	46	46	**44**
1-10	21	27	22	**23**	28	31	33	**31**	43	41	40	**41**
11-20	25	24	23	**24**	33	33	25	**30**	51	45	46	**47**
21-30	24	31	15	**23**	41	28	31	**33**	44	51	46	**47**
31-40	35	26	18	**27**	34	28	31	**31**	42	50	51	**48**
41-50	30	26	10	**22**	33	34	28	**31**	31	43	49	**41**
51-60	23	29	18	**23**	27	31	33	**30**	35	46	47	**43**

Appendix B

Instructions for Experiment (*For Treatment P-neg)*

General Instructions:

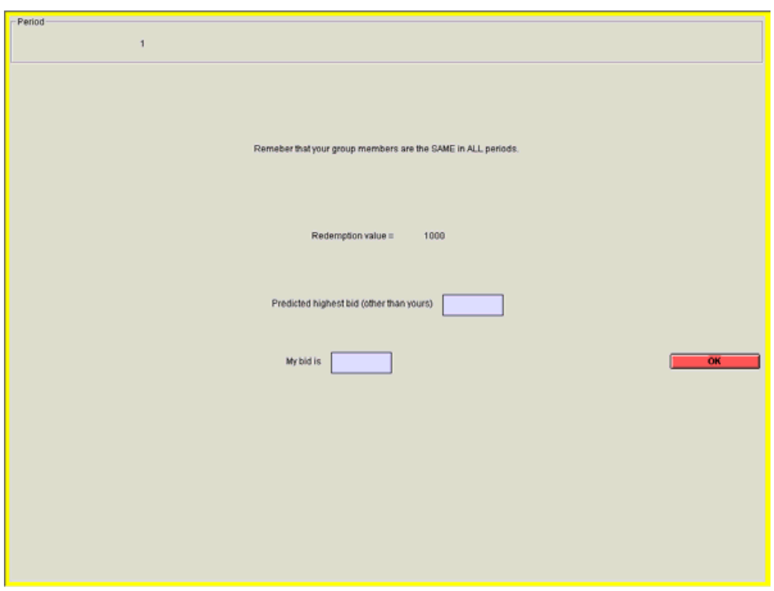
This is an experiment in the economics of decision-making. The instructions are simple, and if you follow them carefully and make good decisions, you might earn a considerable amount of money which will be paid to you in cash. The experiment will consist of 60 periods in which you will be bidding in a series of auctions for units of a good called X.

These instructions are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions, please ask me. If you violate this rule, I shall have to exclude you from the experiment and from all payments.

The currency used in this market is "francs". All bidding in the auctions will be in terms of francs. Your final payoff will be in terms of dollars. The conversion rate is _____ francs to 1 dollar. You will be paid at the end of the experiment.

Detailed Instructions

The experiment consists of 60 periods. In each period the participants are divided into groups of four. You will therefore be in a group with 3 other participants. These groupings will remain **constant** for the **entire experiment**. That is, the participants of your group will be the **same** throughout **all periods**. There will be 1 unit of X sold to each group each period. If you happen to buy a unit of X in a period, you will receive 1000 francs.

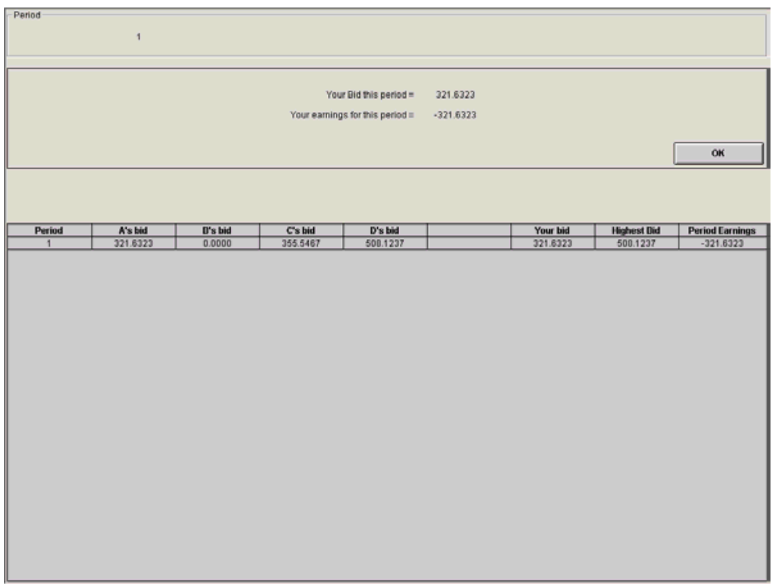


The figure above is an example of the bidding screen for a given period. In the top left corner, the current period is displayed. The REDEMPTION VALUE indicates how many francs you will receive if you are able to buy a unit of X in the auction. Remember that each participant has the same redemption value of 1000 francs. In the space provided next to MY BID IS, you may submit a bid for one unit of X. Your bid can be any amount greater than or equal to negative one thousand -1000 and may be a decimal (up to 4 decimal places). In the space provided next to PREDICTED HIGHEST BID (OTHER THAN YOURS), please enter what you believe will be the highest bid in your group for that period other than your own bid. Once you have entered a bid and prediction, please click on the OK button.

Notice that all the participants of your group make their bids simultaneously without knowing the bid of your group members.

In each period, all of the bids will be ordered from highest to lowest for each group. The highest bid in each group will be accepted and the bidder who made the bid will receive the unit of X. If there is a tie for the highest bid, then 1000 francs will be divided evenly between all the highest bidders.

IN THIS AUCTION, THE AMOUNT THAT YOU BID WILL BE SUBSTRACTED FROM YOUR EARNINGS REGARDLESS OF WHETHER YOU RECEIVE A UNIT OR NOT.



The figure above is an example of a summary screen for fictitious period 1. Once everyone has entered his/her bid for the period, you will be shown a summary screen that presents the decisions of all group members for all completed periods. The first column in the table labeled PERIOD lists the periods that have been completed in the experiment. The columns labeled A's BID, B's BID, C's BID and D's BID list the bids of all group members for the corresponding period. The column labeled YOUR BID lists your bid for each period. The column labeled HIGHEST BID lists the highest bid per period. The column labeled PERIOD EARNINGS lists your earnings for each period. When you are finished viewing the information, please click the OK button. Once everyone clicks the OK button, the program will proceed to the next period.

Determining Your Earnings:

You will receive an initial endowment of 5000 francs at the beginning of the experiment. The amount of your bid each period will be subtracted from your earnings regardless of whether you receive a unit of X or not. If you are the highest bidder and thus purchase a unit of X, your period earnings are 1000 francs minus the amount of your bid. If you are not the highest bidder and bid between -1000 and 0, you will earn 0 minus the amount of your bid. If you are not the highest bidder and bid greater than zero, you will earn negative profit for the period. If you bid more than 1000, you are guaranteed to make negative profit for the period. Your earnings for the entire experiment are the sum of your period earnings plus the initial endowment of 5000 francs.

You earnings each period are calculated as:

If your bid is the highest bid, then your payoff	= - your bid + 1000 francs
If your bid is not the highest bid, then your payoff	= - your bid

The computer will calculate the earnings for you each period.

The three following examples may be helpful in explaining the calculations.

Example 1: Suppose for example that your Redemption Value is 1000 and you submit a bid for 800. Suppose your bid is the highest so that you receive the unit of X being sold. Your earnings for the period equal 1000 - 800 = 200.

Example 2: Suppose that your Redemption Value is 1000 and you submit a bid for 355.89. Suppose your bid is not the highest so that you do not receive the unit being sold. Then your payoff for the period equals 0 - 355.89 = -355.89. You incur losses of 355.89 for the period.

Example 3: Suppose for example that your Redemption Value is 1000 and you submit a bid for -800. Suppose your bid is not the highest so that you do not receive the unit of X being sold. Your earnings for the period equal 0 – (-800) = 800.

Example 4: Suppose for example that your Redemption Value is 1000 and you submit a bid for -800. Suppose your bid is the highest so that you receive the unit of X being sold. Your earnings for the period equal 1000 – (-800) = 1800.

Example 5: Suppose that your Redemption Value is 1000 and you submit a bid for 1200. Suppose your bid is the highest so that you do receive the unit being sold. Then your payoff for the period equals 1000 – 1200 = -200. Even though you have submitted the highest bid and purchase the unit, you still incur losses of 200 for the period.

Quiz: To check your understanding of the experiment, please answer the following questions:

1. Assume that in the first period your bid is 700. Suppose your bid is the highest so that you receive the unit of X being sold.
   a) You earn +300 in the first period.
   b) You earn +700 in the first period.
   c) You earn +1000 in the first period.
   d) You earn +1700 in the first period.
   e) You earn -700 in the first period.

2. Assume that in the first period your bid is 20.751. Suppose your bid is not the highest so that you do not receive the unit of X being sold.
   a) You earn -20.751 in the first period.
   b) You earn 979.249 in the first period.
   c) You earn 1020.751 in the first period.
   d) You earn 1000 in the first period.
   e) None of the above

3. Assume that in the first period your bid is 0. Suppose your bid is not the highest so that you do not receive the unit of X being sold.
   a) You earn -1000 in the first period.
   b) You earn 1000 in the first period.
   c) You earn 0 in the first period.
   d) Bidding 0 is not allowed
   e) None of the above

4. Assume that in the first period your bid is 1100. Suppose your bid is the highest so that you receive the unit of X being sold.
   a) You earn 1100 in the first period.
   b) You earn 1000 in the first period.
   c) You earn -1100 in the first period.
   d) You earn -100 in the first period.
   e) None of the above

5. Assume that in the first period your bid is -700. Suppose your bid is not the highest so that you do not receive the unit of X being sold.
   a) You earn +300 in the first period.
   b) You earn +700 in the first period.
   c) You earn +1000 in the first period.
   d) You earn +1700 in the first period.
   e) You earn -700 in the first period.

6. Assume that in the first period you bid is -700. Suppose your bid is the highest so that you do receive the unit of X being sold.
   a) You earn +300 in the first period.
   b) You earn +700 in the first period.
   c) You earn +1000 in the first period.
   d) You earn +1700 in the first period.
   e) You earn -700 in the first period.

7. Will you ever make a profit if you bid greater than 1000?
   a) Depends on what others bid.
   b) Yes, since it guarantees that I purchase the unit of X.
   c) No, since someone might have still bid more than me.
   d) No, since the redemption value for X is 1000.
   e) None of the above.

Instructions for Experiment (*For Treatment P*)

General Instructions:

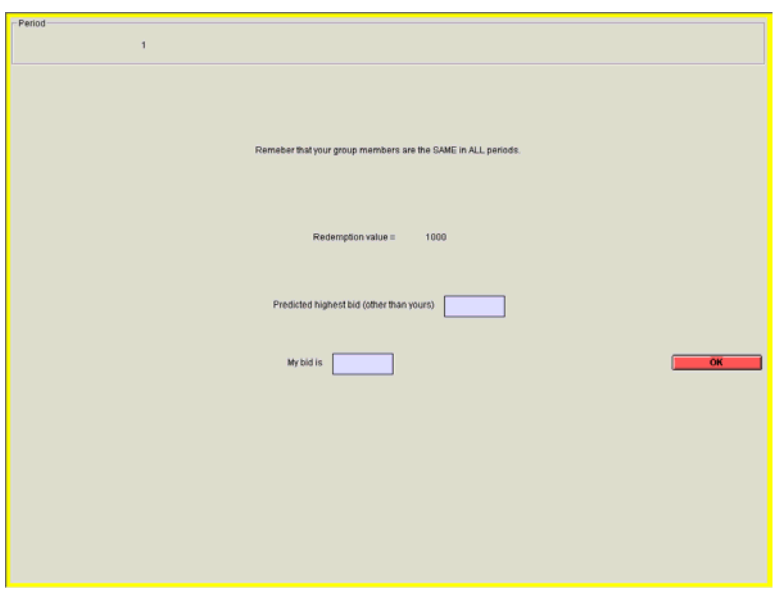
This is an experiment in the economics of decision-making. The instructions are simple, and if you follow them carefully and make good decisions, you might earn a considerable amount of money which will be paid to you in cash. The experiment will consist of 60 periods in which you will be bidding in a series of auctions for units of a good called X.

These instructions are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions, please ask me. If you violate this rule, I shall have to exclude you from the experiment and from all payments.

The currency used in this market is "francs". All bidding in the auctions will be in terms of francs. Your final payoff will be in terms of dollars. The conversion rate is 5275 francs to 1 dollar. You will be paid at the end of the experiment.

Detailed Instructions

The experiment consists of 60 periods. In each period the participants are divided into groups of four. You will therefore be in a group with 3 other participants. These groupings will remain **constant** for the entire **experiment**. That is, the participants of your group will be the **same** throughout **all periods**. There will be 1 unit of X sold to each group each period. If you happen to buy a unit of X in a period, you will receive 1000 francs.

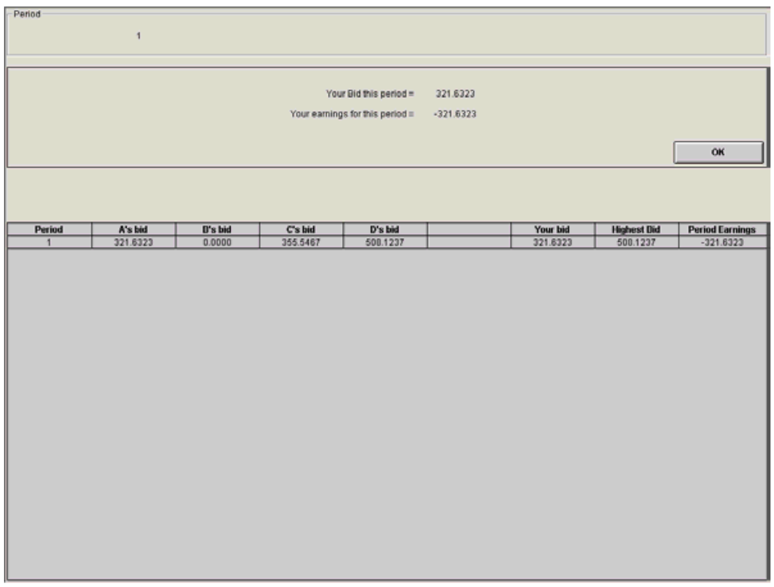


The figure above is an example of the bidding screen for a given period. In the top left corner, the current period is displayed. The REDEMPTION VALUE indicates how many francs you will receive if you are able to buy a unit of X in the auction. Remember that each participant has the same redemption value of 1000 francs. In the space provided next to MY BID IS, you may submit a bid for one unit of X by entering a non-negative bid. Your bid can be any amount greater than or equal to zero and may be a decimal (up to 4 decimal places). In the space provided next to PREDICTED HIGHEST BID (OTHER THAN YOURS), please enter what you believe will be the highest bid in your group for that period other than your own bid. Once you have entered a bid and prediction, please click on the OK button.

Notice that all the participants of your group make their bids simultaneously without knowing the bid of your group members.

In each period, all of the bids will be ordered from highest to lowest for each group. The highest bid in each group will be accepted and the bidder who made the bid will receive the unit of X. If there is a tie for the highest bid, then 1000 francs will be divided evenly between all the highest bidders.

IN THIS AUCTION, YOU MUST PAY THE AMOUNT THAT YOU BID REGARDLESS OF WHETHER YOU RECEIVE A UNIT OR NOT.



The figure above is an example of a summary screen for fictitious period 1. Once everyone has entered his/her bid for the period, you will be shown a summary screen that presents the decisions of all group members for all completed periods. The first column in the table labeled PERIOD lists the periods that have been completed in the experiment. The columns labeled A's BID, B's BID, C's BID and D's BID list the bids of all group members for the corresponding period. The column labeled YOUR BID lists your bid for each period. The column labeled HIGHEST BID lists the highest bid per period. The column labeled PERIOD EARNINGS lists your earnings for each period. When you are finished viewing the information, please click the OK button. Once everyone clicks the OK button, the program will proceed to the next period.

Determining Your Earnings:

You will receive an initial endowment of 65000 francs at the beginning of the experiment. You must pay the amount of your bid each period regardless of whether you receive a unit of X or not. If you are the highest bidder and thus purchase a unit of X, your period earnings are 1000 francs minus the amount of your bid. If you are not the highest bidder, you will earn zero or negative profit for the period (zero if you bid zero, and negative if you bid greater than zero). If you bid more than 1000 francs, you are guaranteed to make negative profit for the period. Your earnings for the entire experiment are the sum of your period earnings plus the initial endowment of 65000 francs.

You earnings each period are calculated as:

If your bid is the highest bid, then your payoff = - your bid + 1000 francs
If your bid is not the highest bid, then your payoff = - your bid

The computer will calculate the earnings for you each period.

The three following examples may be helpful in explaining the calculations.

Example 1: Suppose for example that your Redemption Value is 1000 and you submit a bid for 800. Suppose your bid is the highest so that you receive the unit of X being sold. Your earnings for the period equal 1000 - 800 = 200.

Example 2: Suppose that your Redemption Value is 1000 and you submit a bid for 355.89. Suppose your bid is not the highest so that you do not receive the unit being sold. Then your payoff for the period equals 0 - 355.89 = -355.89. You incur losses of 355.89 for the period.

Example 3: Suppose that your Redemption Value is 1000 and you submit a bid for 1200. Suppose your bid is the highest so that you do receive the unit being sold. Then your payoff for the period equals 1000 – 1200 = -200. Even though you have submitted the highest bid and purchase the unit, you still incur losses of 200 for the period.

Quiz

To check your understanding of the experiment, please answer the following questions:

8. Assume that in the first period your bid is 700. Suppose your bid is the highest so that you receive the unit of X being sold.
    a) You earn +300 in the first period.
    b) You earn +700 in the first period.
    c) You earn +1000 in the first period.
    d) You earn -300 in the first period.
    e) You earn -700 in the first period.

9. Assume that in the first period your bid is 20.751. Suppose your bid is not the highest so that you do not receive the unit of X being sold.
    a) You earn -20.751 in the first period.
    b) You earn 979.249 in the first period.
    c) You earn 1020.751 in the first period.
    d) You earn 1000 in the first period.
    e) None of the above

10. Assume that in the first period your bid is 0. Suppose your bid is not the highest so that you do not receive the unit of X being sold.
    a) You earn -1000 in the first period.
    b) You earn 1000 in the first period.
    c) You earn 0 in the first period.
    d) Bidding 0 is not allowed
    e) None of the above

11. Assume that in the first period your bid is 1100. Suppose your bid is the highest so that you receive the unit of X being sold.
    a) You earn 1100 in the first period.
    b) You earn 1000 in the first period.
    c) You earn -1100 in the first period.
    d) You earn -100 in the first period.
    e) None of the above

12. Will you ever make a profit if you bid greater than 1000?
    a) Depends on what others bid.
    b) Yes, since it guarantees that I purchase the unit of X.
    c) No, since someone might have still bid more than me.
    d) No, since the redemption value for X is 1000.
    e) None of the above.

Instructions for Experiment (*For Treatment S*)

General Instructions:

This is an experiment in the economics of decision-making. The instructions are simple, and if you follow them carefully and make good decisions, you might earn a considerable amount of money which will be paid to you in cash. The experiment will consist of 60 periods in which you will be bidding in a series of auctions for units of a good called X.

These instructions are solely for your private information. **It is prohibited to communicate with the other participants during the experiment.** Should you have any questions, please ask me. If you violate this rule, I shall have to exclude you from the experiment and from all payments.

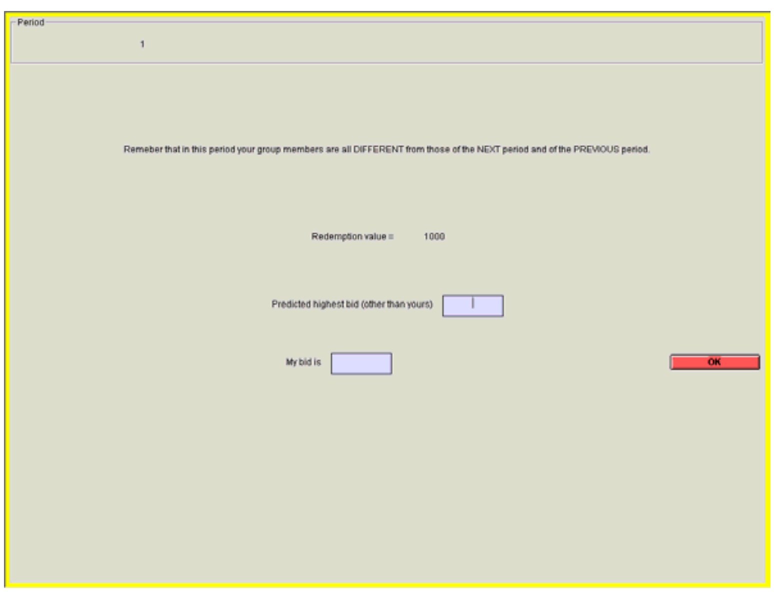
The currency used in this market is "francs". All bidding in the auctions will be in terms of francs. Your final payoff will be in terms of dollars. The conversion rate is _____ francs to 1 dollar. You will be paid at the end of the experiment.

Detailed Instructions

The experiment consists of 60 periods. In each period the participants are divided into groups of four. You will therefore be in a group with 3 other participants. The composition of your group will be changing **every** period. After every period you will be **reassigned** to a **new group** of 4 participants. The probability that you will play with the same group member in two consecutive periods is zero, and the probability that you will play with the same group member in the third following period is very low.

THAT IS, YOU WILL NOT BE MATCHED WITH ANY OF THE SAME GROUP MEMBERS IN ANY TWO CONSECUTIVE PERIODS.

There will be 1 unit of X sold to each group each period. If you happen to buy a unit of X in a period, you will receive 1000 francs.

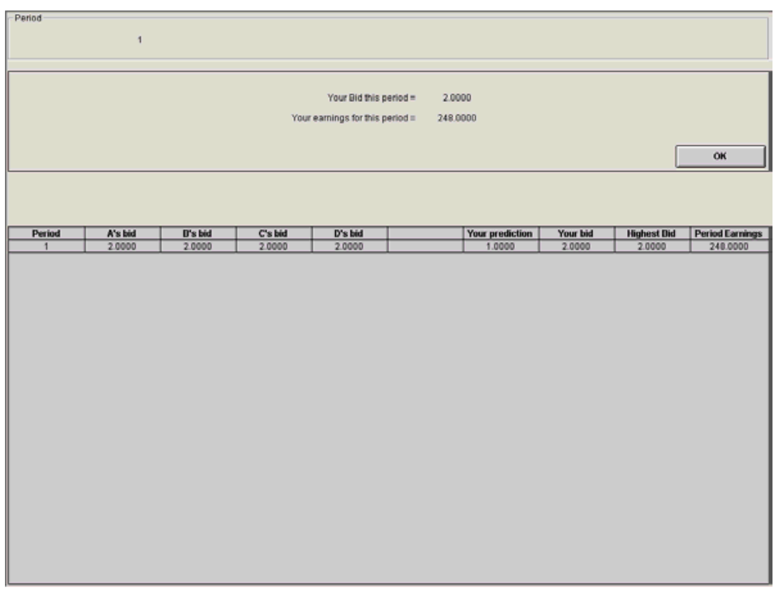


The figure above is an example of the bidding screen for a given period. In the top left corner, the current period is displayed. The REDEMPTION VALUE indicates how many francs you will receive if you are able to buy a unit of X in the auction. Remember that each participant has the same redemption value of 1000 francs. In the space provided next to MY BID IS, you may submit a bid for one unit of X by entering a non-negative bid. Your bid can be any amount greater than or equal to zero and may be a decimal (up to 4 decimal places). In the space provided next to PREDICED HIGHEST BID (OTHER THAN YOURS), please enter what you believe will be the highest bid in your group for that period other than your own bid. Once you have entered a bid and prediction, please click on the OK button.

Notice that all the participants of your group make their bids simultaneously without knowing the bid of your group members.

In each period, all of the bids will be ordered from highest to lowest for each group. The highest bid in each group will be accepted and the bidder who made the bid will receive the unit of X. If there is a tie for the highest bid, then 1000 francs will be divided evenly between all the highest bidders.

IN THIS AUCTION, YOU MUST PAY THE AMOUNT THAT YOU BID REGARDLESS OF WHETHER YOU RECEIVE A UNIT OR NOT.



The figure above is an example of a summary screen for fictitious period 1. Once everyone has entered his/her bid for the period, you will be shown a summary screen that presents the decisions of all group members for all completed periods. The first column in the table labeled PERIOD lists the periods that have been completed in the experiment. The columns labeled A's BID, B's BID, C's BID and D's BID list the bids of all group members for the corresponding period. Your bid for the period will always be in the columns A's BID and YOUR BID. The column labeled HIGHEST BID lists the highest bid per period. The column labeled PERIOD EARNINGS lists your earnings for each period. When you are finished viewing the information, please click the OK button. Once everyone clicks the OK button, the program will proceed to the next period.

Determining Your Earnings:

You will receive an initial endowment of 65000 francs at the beginning of the experiment. You must pay the amount of your bid each period regardless of whether you receive a unit of X or not. If you are the highest bidder and thus purchase a unit of X, your period earnings are 1000 francs minus the amount of your bid. If you are not the highest bidder, you will earn zero or negative profit for the period (zero if you bid zero, and negative if you bid greater than zero). If you bid more than 1000 francs, you are guaranteed to make negative profit for the period. Your earnings for the entire experiment are the sum of your period earnings plus the initial endowment of 65000 francs.

You earnings each period are calculated as:

If your bid is the highest bid, then your payoff	= - your bid + 1000 francs
If your bid is not the highest bid, then your payoff	= - your bid

The computer will calculate the earnings for you each period.

The three following examples may be helpful in explaining the calculations.

Example 1: Suppose for example that your Redemption Value is 1000 and you submit a bid for 800. Suppose your bid is the highest so that you receive the unit of X being sold. Your earnings for the period equal 1000 - 800 = 200.

Example 2: Suppose that your Redemption Value is 1000 and you submit a bid for 355.89. Suppose your bid is not the highest so that you do not receive the unit being sold. Then your payoff for the period equals 0 - 355.89 = -355.89. You incur losses of 355.89 for the period.

Example 3: Suppose that your Redemption Value is 1000 and you submit a bid for 1200. Suppose your bid is the highest so that you do receive the unit being sold. Then your payoff for the period equals 1000 – 1200 = -200. Even though you have submitted the highest bid and purchase the unit, you still incur losses of 200 for the period.

Quiz

To check your understanding of the experiment, please answer the following questions:

13. Assume that in the first period your bid is 700. Suppose your bid is the highest so that you receive the unit of X being sold.
    a) You earn +300 in the first period.
    b) You earn +700 in the first period.
    c) You earn +1000 in the first period.
    d) You earn -300 in the first period.
    e) You earn -700 in the first period.

14. Assume that in the first period your bid is 20.751. Suppose your bid is not the highest so that you do not receive the unit of X being sold.
    a) You earn -20.751 in the first period.
    b) You earn 979.249 in the first period.
    c) You earn 1020.751 in the first period.
    d) You earn 1000 in the first period.
    e) None of the above

15. Assume that in the first period your bid is 0. Suppose your bid is not the highest so that you do not receive the unit of X being sold.
    a) You earn -1000 in the first period.
    b) You earn 1000 in the first period.
    c) You earn 0 in the first period.
    d) Bidding 0 is not allowed
    e) None of the above

16. Assume that in the first period your bid is 1100. Suppose your bid is the highest so that you receive the unit of X being sold.
    a) You earn 1100 in the first period.
    b) You earn 1000 in the first period.
    c) You earn -1100 in the first period.
    d) You earn -100 in the first period.
    e) None of the above

17. Will you ever make a profit if you bid greater than 1000?
    a) Depends on what others bid.
    b) Yes, since it guarantees that I purchase the unit of X.
    c) No, since someone might have still bid more than me.
    d) No, since the redemption value for X is 1000.
    e) None of the above.

Record Sheet (*Used for all Treatments)*

Period	Earnings	Period	Earnings
1		31	
2		32	
3		33	
4		34	
5		35	
6		36	
7		37	
8		38	
9		39	
10		40	
11		41	
12		42	
13		43	
14		44	
15		45	
16		46	
17		47	
18		48	
19		49	
20		50	
21		51	
22		52	
23		53	
24		54	
25		55	
26		56	
27		57	
28		58	
29		59	
30		60	

		Total Earnings Calculation	
		5000	(Endowment)
	+	______	(Sum period earnings)
		______	(Total Earnings)