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MINORITY vs. MAJORITY: AN EXPERIMENTAL STUDY OF STANDARDIZED BIDS

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Abstract

Due to its simplicity the plurality voting system is frequently used to choose a common representative or project. Nevertheless it may fail to provide a socially efficient decision as a majority can outvote any minority even if the majority's gain does not compensate the loss suffered by the minority. In this paper we propose and study a simple mechanism that allows voters to reveal more information about their preferences over the candidates. According to the *standardized bids mechanism* voters report a bid for all the available projects. Standardization ensures the existence of equilibrium, and delivers incentives to overcome the problem of positive and negative exaggeration. Our experimental results show that the *standardized bids mechanism* performed well in the laboratory as it chose the efficient project in almost three quarters of the cases, and induced truthful reports of project rankings in approximately 90% of the cases. For a reference, we also present experimental results for the plurality voting scheme.

Keywords: efficiency, experiments, mechanism design, public project, uncertainty, voting rules

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1 Introduction

Voting rules are perhaps best known for their use in political elections, however they are frequently used to aggregate the preferences of self-interested agents and make other public decisions and choose common projects. Most voting systems are based on the concept of majority rule, i.e. the alternative that is supported by more than half of the voters is elected and carried out.[1]

Since its introduction in the Athenian democracy, voting has been used as an essential feature of democracy since the 6th century BC.[2] The plurality voting scheme, according to which the alternative with the largest number of votes is chosen, may well be the simplest of all voting systems. For this reason, it is likely to be quicker, easier and cheaper to administer than others. Moreover its rules may also be easier to explain and understand, while alternative hard-to-understand voting systems may alienate some voters as the effect of their own vote is obscured by the complex decision rule.

Nevertheless, to a much greater extent than many other methods, plurality voting encourages tactical voting. In particular, voters are pressured to vote for one of the two candidates they predict are most likely to win, even if none of them is their true top choice. It is so, because a vote for any other candidate will be likely to be wasted and have no impact on the final result. The other big disadvantage of the plurality voting system is that majority groups can use it to impose their decisions on minorities.[3] Historical examples for this include Northern Ireland where the majority group of the Protestants always imposed its will until the Catholic minority began to rebel, or the so called Jura problem between the French speaking minority and the German speaking majority in Switzerland.[4] In the latter case, to come to a solution, in

[1]The first part of the introduction is based on Mueller (2003).

[2]The earliest recorded elections in Athens were based on plurality vote, but by that time winning was undesirable. In the ostracism process, Athenians chose the citizen they most wanted to exile for ten years.

[3]Consider the example (Mueller, 2003) where a community proposes to finance fire protection via a proportional property tax but the town meeting makes decisions under the majority rule. The town's wealthiest citizens caucus and propose a lump-sum tax on all property owners. Although this proposal is opposed as being regressive by the less wealthy citizens, a majority coalition of the rich succeeds in combining the provision of fire protection with a regressive tax on the poor under the majority rule. A discussion on when the majority rule can/should not be used can be found in Mueller (2003).

[4]In 1815, the French speaking Jura was given to the German speaking Bern canton as compensation for territories that Bern had lost after its defeat by the armies of Napoleon. The opposition towards this arrangement from both sides generated stormy relations in the 19th century.

the 60s heavy use was made of the referendum. Yet referenda by definition are based on the majority principle and therefore are contrary to the Swiss consociational model. Even if it is true that in Switzerland there has been many cases where the referendum is used by a majority to outvote minorities, the Jura issue shows that referenda can also be used in a consociational manner and protect the minority from the tyranny of the majority: this could be done by using not a single referendum but a whole series of referenda.[5] Many of today's complex electoral systems are designed in this spirit, i.e. in order to protect minorities from the majority.[6] A more recent example for the relevance of the debate on the relations between a majority and any minority is the reform of the voting scheme for making EU laws by the Council of Ministers in the European Union, after the steady enlargement of the Union. The proposal of the EU constitution – that can be a counterexample of increasing the weight of minorities in political decisions – constitutes a shift to a primarily population-based voting system abolishing the actual weighted voting system. According to the proposal EU laws would be made by "double majority" of states and population, i.e. it requires 55% of the member states, at least 15, as long as they include 65% of the EU's population. This change would make it easier for the large states with large population to get their way by reducing the relative voting weight of middle-rank and smaller member states; and so a blocking minority would be harder to assemble than before, making EU laws easier to pass.

The objective comparison of voting systems is a difficult task. In the real world, attitudes toward one system or the other are influenced by the systems' impact on groups that one supports or opposes. In order to compare systems fairly theorists use a list of potentially desirable properties. The most important ones are efficiency (the selected project should be the socially desirable one), Bayesian incentive compatibility (participants should have incentives to act truthfully and reveal their private information), individual rationality (participants should prefer participating

[5]Finally, a series of referenda allowed the French speaking Catholics to create in 1979 a new canton and the French speaking Protestants to stay within the old canton.

[6]Let us recall three other historical examples in this footnote. The French writer and statesman Alexis de Tocqueville's work about the tyranny of the majority has become seminal to the study of human rights. The French Revolution witnessed one of the most cruel oppressions upon the minority that in a democracy a majority of the people is capable of. James Madison, the fourth President of the United States, who is credited with making the Bill of Rights part of the US Constitution, wrote in the Federalist Paper that it was of great importance in a republic not only to guard the society against the oppression of its rulers but to guard one part of the society against the injustices of the other part. If the majority was united by a common interest, the rights of the minority would be insecure.

in the mechanism to abstaining), and budget balance (the mechanism should be possible to operate without having to invest or destroy any non-zero amount of money). Well-known theoretical results establish the impossibility for one voting system to pass all criteria in common use. Arrow's impossibility theorem, for instance, demonstrates that several desirable features of voting systems are mutually contradictory.[7] Other highly valued properties of a voting scheme are strategy-proofness and (social) efficiency. The Gibbard-Satterthwaite theorem shows that strategic voting is unavoidable in certain common circumstances, i.e. when there are three or more candidates, all reasonable voting rules are manipulable. Regarding efficiency, the voting systems that do not take into consideration the intensity of preferences (as for example the plurality voting) often fail to select the socially efficient outcome, even without manipulation.[8]

Results dealing with the manipulation and the social efficiency of mechanisms are also present in the experimental literature. For example, Polomé (2003) reports data on deliberate misrepresentation of preferences from a referendum contingent survey. He finds that only half of the subjects voted truthfully in the laboratory. Nevertheless there also exists important experimental evidence showing that certain mechanisms may be difficult to manipulate due to their complexity.[9] Experiments typically confirm that as the voting space enlarges to include more projects or more voters, the computational difficulty of sophisticated voting increases. Herzberg and Wilson (1988) report empirical results on voting in a simplified agenda setting from laboratory experiments. They find that participants have difficulties calculating sophisticated strategies (whether faced with short or long agendas), and conclude that sophisticated behavior is relatively uncommon even in very simple settings.[10] A recent work by Bassi (2007) studies strategic behavior in three voting systems: plurality voting, approval voting, and the Borda count. Surprisingly, she finds that under the plurality rule the preference manipulation is less frequent than under the other two methods, but plurality voting performs much worse regarding Condorcet efficiency. Regarding social efficiency she does not find significant differ-

[7]These features are unrestricted domain, non-imposition, non-dictatorship, monotonicity, and independence of irrelevant alternatives. Check Mas-Colell et al. (2004).

[8]For an example, see example 1 on page 7.

[9]Harrison and McDaniel (2005) offer a brief review on this in the introduction. They present experimental results and argue that a "voting rule that is simple to explain and implement may still be cognitively difficult to strategize against".

[10]Participants had full information about the preferences of the others and voted for a fixed agenda without any uncertainty about the strategies chosen by the others, as if they were truth-telling robots.

ences across the three voting rules.

In this paper we propose and study a mechanism rule that allows voters to reveal more information about their preferences over the set of available projects (candidates), regarding social efficiency. According to this *standardized bids mechanism* voters report a real number, that we call bid, for all the available projects. Bids are standardized before being summed up to select the winner. The project (candidate) with the largest aggregated standardized bid is selected winner. In practice this means that the bids taken into account by the mechanism always sum up to zero, and have unit variance for each agent. Standardization ensures the existence of equilibrium, and delivers incentives to overcome the problem of positive and negative exaggeration. Our experimental results show that the standardized bids system performed well in the laboratory as it chose the efficient project in more than three quarters of the cases, and induced truthful reports of project rankings in approximately 90% of the cases. As predicted by theory, efficiency increased with the number of voters. For a reference, we also present experimental results for the plurality voting system that produced efficient decisions in 63% of the cases. Here, we focus on the efficiency of the proposed standardized bids mechanism, because the other requirements of individual rationality and budget balancedness are met by construction. Although in this paper it is not our main objective to study strategic behavior of the agents—in our actual setting this does not make sense, as agents bear incomplete information—we report some results on the incentives to truth-telling in both mechanisms.

Besides the simple plurality vote scheme the standardized bids mechanism can be related to a number of mechanisms proposed for making public decisions. In the storable votes model proposed by Casella (2005) each voter is granted a stock of votes to spend as desired over a series of binary decisions. The possibility of shifting votes from one decision problem to an other allows agents to concentrate their votes when their preferences are more intense. Although it does not achieve full efficiency, the storable votes scheme typically leads to welfare gains over non-storable votes.[11] Casella et al. (2007) applied the storable votes scheme in an environment similar to ours, i.e. in the case of committees with minorities. It turns out that storable votes

[11]Concerned about the complexity of the equilibrium behavior in the storable votes scheme Casella et al. (2006) report experimental data related to the implementation of the mechanism. They find that realized efficiency levels were remarkably close to theoretical equilibrium predictions, even though subjects adopted off-equilibrium strategies.

induce a rise (or a little fall) in aggregate efficiency. The theoretical predictions of the model are backed by experimental data showing that equilibrium strategies are rarely observed in the lab. However, the monotonicity, i.e. more votes are cast if preferences are more intense, is almost always respected.

Motivated by the same problem, Hortala-Vallve (2006) proposes the qualitative voting scheme to solve the conflict between the minority and the majority. In this case voters are endowed with a certain number of votes that can be distributed freely among the available projects or candidates. Hortala-Vallve solves the theoretical model in two special cases (two-voters and three-voters case) and finds that it dominates the majority rule in terms of efficiency.

All schemes discussed above, the storable votes model, the qualitative voting scheme and our proposal of standardized bids can be related to the linking of independent decisions through a common budget constraint. As Jackson and Sonnenschein (2007) show it, this can be used to elicit preferences. They offer an interesting proposal for public decision problems that operates without monetary transfers by proving that the utility costs associated with incentive constraints decrease when the decision problem is linked with independent copies of itself. While the linking mechanism requires the knowledge of the entire probability distribution that characterizes uncertainty in the economy, Veszteg (2007) studies a modified linking mechanism. He shows that while allowing for heterogeneity among problems and agents, the linking mechanism keeps its asymptotic properties when run with solely the first two moment conditions - the mean and the variance. This is precisely what our standardized bids mechanism makes use of.[12]

The multibidding mechanism introduced by Pérez-Castrillo and Wettstein (2002) can be used under complete information to find the ex post efficient project. As in the standardized bids scheme, the participants are also required to bid for all available projects, but there is only one condition to be met: bids must sum up to zero for every agent. Veszteg (2004) studies the multibidding game theoretically, and Pérez-Castrillo and Veszteg (2007) do it in the experimental lab in situations in which agents' valuations are private information. It turns out that the mechanism performs well in both cases in extracting private information and finding the

[12] Similar idea lies behind the storable votes and also behind the qualitative voting models. The fixed number of available votes restricts voters and poses a bound to exaggerations. However it is not clear how the number of available votes should be determined in either case. In particular, why one vote per period should be optimal when votes are storable.

efficient project, however it is not 100% accurate.

While the multibidding game operates with money and monetary transfers among the agents, there exist a number of mechanisms designed to overcome some of the shortcoming of the plurality rule. Ranked—or preferential—voting methods allow voters to rank the candidates in order of preference. Once all votes have been counted the alternative with the most points is selected.[13] Ranked methods use more information than the plurality rule when determining the winning alternative, as the latter ignores all information that is not related to the project with the highest rank. Our proposal, the standardized bids method, is a rated voting scheme, because voters give a numeric score to each alternative. Although these scores are somewhat distorted by the standardization, or the fixed first two moment conditions, and typically do not coincide with true preferences, their informational content is higher than in the case of the previously discussed scheme. This is the intuition that lies behind the theoretical and experimental results that we present in the paper.

The paper is organized as follows. Section 2 presents the underlying decision problem formally that can be handled with the plurality voting scheme, presented for later comparison in section 3, and our proposal the standardized bids mechanism. The theoretical results regarding the latter are in section 4, while sections 5 and 6 contain experimental evidence. Section 7 concludes. Statistical tables and mathematical proofs can be found in the appendix. We have prepared a long version of the appendix with more statistical results and the translation of the instructions used in the experiment.[14]

2 Choosing a joint project

Let us consider a situation in which a group of people, $N = \{1, 2, ..., n\}$, has to make a common decision, i.e. to choose a project from the set of the available ones, $P = \{1, 2, ..., m\}$. In order to deal with an interesting problem suppose that $n \geq 2$ and $m > 2$. The former restriction is necessary for the existence of a possible conflict of interest between agents, while the latter ensures that there are enough projects to choose from. Assume that agents' valuations for

[13] A well known example for a ranked voting method is the Borda count that is often described as a consensus-based electoral system, rather than the majority (plurality) rule, because it tends to elect broadly acceptable candidates, rather than those preferred by the majority (plurality).

[14] The web appendix is available at http://rveszteg.googlepages.com/stbidsweb.pdf

the available projects are privately known. Let vector $x_i = (x_i^1, x_i^2, ..., x_i^m)$ denote agent i's valuations for the m projects. In general, we allow for both positive and negative valuations, therefore $x_i^j \in R$ for all $i \in N$ and $j \in P$. Uncertainty due to the fact that people withhold important information related to the decision problem is present in the model in form of the distribution function F that is common knowledge. Valuations are assumed to be independently distributed according to the same distribution function among agents and projects. Formally, $x_i^j \sim iiF$.

In this paper we consider two simple mechanisms that operate without money transfers and can be used to make collective decisions. The first one is the plurality voting scheme according to which every agent is asked to place a vote for a single project. After the simultaneous voting the project that has received the most votes is chosen and carried out.[15] This mechanism is frequently used in real life and for this reason has also attracted the attention of theorists. We wish to contribute to the mechanism design literature by proposing an alternative mechanism that we call *standardized bids mechanism*. As it is shown in the paper, the attractive feature of the standardized bids mechanism in general is that it is able to outperform simple voting schemes in terms of efficiency, due to the fact that it allows for bids whose sign and also absolute value carry meaningful information about individual valuations. The following sections of the paper introduce the formal definition of the mechanism, study its performance and compare it to the plurality voting scheme.

3 Plurality vote

The plurality voting scheme is a very simple and widely used mechanism to make social decisions. As a generalized version of the majority rule it is frequently studied both from a theoretical and empirical point of view in the literature.[16] According to the plurality protocol, the social choice mechanism ignores most of the preference patterns of the voters by considering only the most preferred option from each individual. In short, every participant has one vote and the project that receives the most votes wins. This implies that even if people vote in a sincere

[15]Ties can be broken with the help of some random device.

[16]Among others, check for example Ladha et al. (1996), Myerson and Weber (1993), and Eavey and Miller (1984).

manner the mechanism ignores the intensity of their preferences and therefore it may occur that the loss suffered by an outvoted minority is larger than the gain of the victorious majority. The following stylized example illustrates this idea.

Example 1. *Suppose that there are three voters (1, 2, and 3) and three projects (A, B, and C). The private valuation of these projects are the following: voter 1 values project A at 50 and the other two projects at 0, while voters 2 and 3 value project B at 10 and the other projects (A and C) at 0. Supposing that voters vote truthfully according to the rules of plurality voting, voters 2 and 3 will outvote the project A, and project B will be chosen (winning 2:1 against A). Clearly, this outcome is not the socially efficient one, that one would be the project A (as project A yields a social wealth of 50 while project B only of 20).*

Although the data of our second example from the 1992 US elections is only approximate and should not be blindly accepted, it demonstrates another important characteristic of the plurality voting scheme.

Example 2. [17] *Consider voting in Ohio during the 1992 U.S. presidential election with three candidates, Clinton, Bush, and Perot. In 1992, there were about 10.8 million residents of Ohio. Assume about 55% of these residents voted in 1992, so assume that about 6 million people voted. According to some numbers available publicly, the distribution of these votes were approximately as follows: 40% (2.4 million) for Clinton, 38% (2.28 million) for Bush, and 22% (1.32 million) for Perot. According to the total votes, Clinton clearly won the election. However, suppose that Perot had not been running for office. Popular opinion indicates that Perot took more votes from Bush than from Clinton, so let's assume that the distribution of votes without Perot in 1992 would mimic the distribution of votes between Dukakis and Bush in 1998. Under these circumstances, the votes in 1992 would be approximately as follows: 45% (2.7 million) for Clinton, and 55% (3.3 million) for Bush. Clearly, Bush would have won.*

This example shows that—technically speaking—the plurality voting scheme is not independent of irrelevant alternatives. While the standardized bids mechanism is not independent either, the next sections deliver evidence that it does constitute an improvement in terms of efficiency with respect to the plurality vote protocol.

[17] This example is taken from Mike Goodrich's lecture notes published on Internet at http://students.cs.byu.edu/∼cs670ta/

4 Standardized bids

The mechanism of standardized bids, to be defined in this section, is related to the multibidding game defined in a complete information framework by Pérez-Castrillo and Wettstein (2002). Veszteg (2004) and Pérez-Castrillo and Veszteg (2007) define and study theoretically and experimentally a two-project version of the multibidding game that operates under uncertainty. According to its rules agents are asked to bid for both available projects and the one that most bids received is carried out. In order to avoid exaggeration and deliver proper incentives individual bids must meet a moment condition: they must sum up to zero.

In a different framework without money and with possibly more than two projects, Veszteg (2004) shows that, under certain conditions, imposing two moment conditions delivers a useful, fairly general, yet sufficient method to achieve ex post efficient decisions in large societies. Here we shall introduce an additional condition on the second moment of the individual bids.[18]

According to the rules of the standardized bids mechanism every agent is required to bid for all the available projects, and the bids must meet two moment conditions. Let the vector $y_i = (y_i^1, y_i^2, ..., y_i^m)$ denote agent i's bids, i.e. messages. Then the following two equalities must hold for all agent, $i \in N$, with μ and σ being constant reals:

$$\frac{1}{m}\sum_{j=1}^{m} y_i^j = \mu; \qquad (1)$$

$$\frac{1}{m}\sum_{j=1}^{m} (y_i^j - \bar{y})^2 = \sigma^2. \qquad (2)$$

Agents solve a constrained maximization problem as they maximize their utility subject to the restrictions above. We assume that if project j is chosen and carried out agent i enjoys a utility of x_i^j, while if project j is not chosen people do not feel envy, fury or suffer any utility loss. In that case agent i extracts 0 utility from project j. The winning project is chosen taking into account the aggregate bid: project j is carried out if it is the project that receives the most bids. In case of a tie a random device can be used to select a single project from those that obtained the largest aggregated bid. Formally, if Y^j denotes the aggregate bid for

[18] We study a problem with more than two available projects. If $m = 2$, imposing two moment conditions reduces the mechanism into a voting scheme, since in that case the set of vectors of possible messages has only two elements.

project j, or in mathematical terms if $Y^j = \sum_{i=1}^{n} y_i^j$, then project j is the winning project if $j \in argmax_{k \in P} Y^k$.

As shown in the appendix, agent i's decision problem can be formally summarized by the following maximization problem:

$$max_{\{y_i^j\}_{j=1}^m} \sum_{j=1}^{m} x_i^j \cdot Pr(j \in argmax_{k \in P} Y^k) \tag{3}$$

such that equations/conditions 1 and 2 hold. Although unfortunately we do not have theoretical results on the Bayes Nash equilibria of the game, it can be proved that the solution to the maximization problem in equation 3 preserves the truthful ranking of the decision problems.

Proposition 1. *The individual equilibrium strategies of the standardized bids mechanism report the ranking of the projects truthfully. For any agent $i \in N$, if for some j and $k \in P$ $x_i^j > x_i^k$ holds, then $y_i^j \geq y_i^k$.*

Proof. In the appendix. □

In the mechanism design literature, mechanisms are usually characterized by a list of desirable properties that they fulfill. Note that in our setup budget balance and individual rationality are not an important issue due to the lack of monetary transfers and costs of participation.[19]

It is important to bear in mind that although the standardized bids mechanism gives the right incentives to participants for reporting the ranking of the available projects truthfully, it is not strategy-proof, since players do not reveal their private information in the equilibrium. The above result holds, and can be proven very similarly, without the use of approximate independence of probabilities. The only critical assumption concerns the anonymity of the mechanism, that is, the equilibrium strategy should be unaltered (qualitatively) if we change the labeling of projects. Therefore, the technical assumption of private valuations being independent and identically distributed across the projects is crucial. Even if the above proposition allows for equal bids for projects that represent the same value for the player, the rules of the mechanism—namely that the second moment condition must hold—rule out the strategy of bidding the same

[19]The Myerson-Satterthwaite theorem shows that there does not exist a mechanism that satisfies interim individual rationality, balance, efficiency, and Bayesian incentive compatibility for a general set of distributions. For more details check Jackson (2003).

amount for all projects under consideration. For this reason the most and the least preferred project by an agent will receive different bids and moreover, she will rank these projects truthfully. Nevertheless we cannot completely rule out equal bids for projects with the same value for a player.

Perhaps an indirect version of the standardized bids mechanism is easier to implement, because finding a list of numbers with a given mean and variance involves quite a series of computations. Therefore the social planner could announce a direct mechanism in which she asks for private valuations without imposing the moment conditions, but in the election of the winning project not these numbers, but their standardized values will be taken into account.[20]

The mechanism design literature usually considers a social planner whose objective is to achieve ex post efficiency. This means that the project with the largest social value, i.e. sum of private valuations, should be carried out. Formally, j is an ex post efficient project if

$$j \in argmax_k \sum_{i \in N} x_i^k. \tag{4}$$

Mechanisms, e.g. the multibidding game under complete information and uncertainty, often use the above expression to determine the winning project, but they naturally sum up the observable messages, y_i^j, rather than the unobservable private valuations, x_i^j. If one looks at problems with more that 2 agents it turns out that since efficiency is defined in a linear form, truthful direct mechanisms, and indirect mechanisms with linear equilibrium bidding functions are ex post efficient.[21] For example, Veszteg (2004) finds in the proposed public decision problem that as the number of players increases, the optimal bidding function tends to be *more* linear. The efficiency of the multibidding game under uncertainty with two projects therefore increases with the number of agents involved.

Example 3. *Given that the efficiency analysis often can not be done analytically we propose the use of a simple statistical measure (Table 1), the coefficient of linear correlation, as a proxy for ex post efficiency of the multibidding game with moments. These numerical examples deliver numerical evidence and further intuition to this practice. We use computer simulation with*

[20]This is a special case of the before presented mechanism as standardization sets $\mu = 0$ and $\sigma^2 = 1$. Nevertheless the value of these parameters does not influence the chosen project or the efficiency of the mechanism.

[21]In case of conflicts that involve only two agents efficiency does not require these conditions.

100,000 random draws to compare the plurality voting and the proposed standardized bids mechanism assuming truth-telling.

Table 2 shows that as the number of projects increases the proportion of ex post efficient decisions delivered by the standardized bids mechanism also increases. In case of the plurality voting scheme an increase in the number of projects works against the mechanism's efficiency. Table 3 reports the results of the simulation for realized efficiency of both mechanisms. In this case the social value of the selected project is compared to the social value of the efficient project. For this type of comparison to be meaningful one needs non-negative private valuations, this is why *only* the uniform case over the interval $[0;1]$ is presented in the table. An increase in the number of participants increases the realized efficiency of both voting schemes, but just as with the proportion of ex post efficient decisions, an increase in the number of projects reduces the efficiency of the plurality vote, while increases the one of the standardized bids scheme.

Given the definition of ex-post efficiency in equation 4, the question whether the society should carry out a project or elect a candidate that is supported by a minority has a straightforward answer. This utilitarian approach that assigns the same weight to every citizen is frequently applied in the theoretical literature. Its empirical implementation is considered as problematic due to informational asymmetries and voters' strategic behavior. The proposed standardized bids mechanism aims precisely at reducing this problem and presents a way of aggregating individual messages (i.e., votes or bids) delivered by different individuals who act strategically.

The rest of the paper presents experimental evidence on the performance of the standardized bids mechanism.

5 Experimental design

We recruited two groups of 24 subjects to a computer lab through announcements posted across the campus of the Universitat Autònoma de Barcelona in Bellaterra, Spain, for the first session and through an online recruiting system for the second one. They were informed that they would participate in a paid experiment on decision making. The experiment was programmed and conducted with the software z-Tree (Fischbacher, 2007). The first session took place in

June and the second in November 2006. We implemented three treatments in both sessions.[22] At the beginning of each treatment, printed instructions were given to subjects and were read aloud to the entire room. Instructions explained all rules to determine the resulting payoff for each participant. They were written is Spanish, contained a numerical example to illustrate how the program works, and presented pictures of each screen. The English translation of the instructions, without pictures, can be found in the web appendix.

In each round the computer randomly assigned subjects to groups. We used anonymous stranger matching, i.e. participants were not informed about who the other members of their group were, and a new assignment was made in every period; hence participants knew that the groups were typically different from period to period. Subjects were not allowed to communicate among themselves; the only information given to them in this respect was the size of the group.

In the first two treatments of session 1 groups of three were formed, while in the third treatment subjects played in groups of six.[23] In the first treatment the plurality voting scheme was implemented to choose a joint project from three available alternatives, while in the last two treatments subjects played according to the rules of the standardized bids mechanism to chose again from the three projects. In session 2 we changed the order of the two mechanisms in order to check for a possible order effect. As it is explained in more detail in the next section the different sequencing did not change results fundamentally.

Private valuations for the three projects at each round were assigned to subjects by the computer in a random manner. We used the built-in function of z-Tree to generate random draws from the set $\{0; 10; 50\}$ assigning the same probability to every possible value.[24] For this reason, valuations for the alternatives were typically different in each round and for each subject. As our main objective is to analyze the performance of the standardized bids mechanism regarding efficiency and not the study of the strategic behavior of agents, subjects had incomplete information: they were not told the private valuations of the other players.

[22]Table 4 offers a brief summary of our treatments for later reference.

[23]As group size seems to be an important determinant of the efficiency of the mechanisms (see the results of the simulation), we decided to include a treatment with increased group size. Taking into account the time limit of a laboratory experiment, we also believe that increasing the number of participants per group rather than the number of projects is more realistic.

[24]These values were chosen to capture the main characteristics of both the plurality voting scheme and the standardized bids mechanism.

In session 1 treatments consisted of one practice period and 7 paying rounds in the plurality vote scheme, and 10 paying rounds under the standardized bids system. In session 2 subjects played one practice and 15 paying rounds in each treatment. Subject were asked to decide in three independent situations in each round, after having carefully explained them that these situations were to be treated separately.

For computational convenience, numbers (valuations, bids, and gains) used in the experiment were rounded to integers. Since the standardized bids mechanism involves standardization, a probably fairly complicated operation for some subjects not trained in mathematics, after the bidding period the computer informed the subjects about the standardized values of their bids (with 2-digits precision) that later would be used to choose the winning project.

In each round, participants were asked to enter their bids over the three projects. After it the winning project was determined according to the rules of the actual mechanism and payoffs were calculated automatically by the computer.[25] At the end of each round subjects received on-screen information about the aggregated bid of other players in the same group and about their personal final payoff. For convenience—and in order to keep subjects informed about their performance—the history of personal earnings was always available on screen during the experiment.

Each session lasted an hour and a half. At the end participants were paid individually and privately. Final profits were computed from the personal gains of the whole session (in experimental monetary units), using a simple conversion rule: 180 experimental monetary units were equal to EUR 1. Taking into account the three treatments, individual net payments (excluding the EUR 3 show-up fee) ranged from EUR 7.33 to EUR 12.95, with a mean of EUR 10.34 in the first session, and from EUR 11.61 to EUR 20.94 with a mean of EUR 17.09 in the second.[26]

In table 5 we report expected (based on the theoretical model and numerical simulations) results taking into account the discrete distribution of private valuations in our experiment. In particular we computed the proportion of ex post efficient decisions and realized efficiency assuming truthful behavior, and the correlation between private valuations and messages (votes/bids).

[25] In case of a tie, the program breaks the tie choosing the winning project randomly, assigning equal probability to the alternatives with the highest number of votes/bids.

[26] The difference between individual earnings across sessions is mainly explained by the fact that in the second session subjects played more periods of the games.

6 Experimental results

In this section we present a concise statistical analysis of the experimental data that we collected in our three treatments. The first subsection describes the global performance of the standardized bids mechanism, while the second one concentrates on individual bidding behavior. Apart from reporting the usual statistical estimates we also make use of the recombinant estimation method suggested by Mullin and Reiley (2006). Following their suggestions we consider all possible groups of our subjects, therefore instead of 8 observations we deal with 2024 observation in each period in the PV and the SB3 treatments. In case of the SB6 treatment we consider 134,596 observations per period and not only the original 3.[27] This methods improves the efficiency of the statistical estimates and is able to alleviate possible problem due to small sample size.

6.1 Efficiency and information extraction

Table 6 presents a summary of experimental results from our six treatments in two sessions. The numbers are computed taken into account all paying periods from the experiments. In order to detect some possible starting and/or ending effect bias we computed the same measures for different periods (ignoring the first and/or last one or two periods). There does not seem to exist important learning and/or ending effects, nor robust and significant differences between the two sessions. We do not include these estimation details here, however they appear in the web appendix of the paper. The data confirms the ranking between the two mechanisms regarding the proportion of ex post efficient decisions, suggested by theory. The difference between the PV and the SB is significant at 3%. In session 2 the difference with the original grouping is much smaller in absolute value and is not significant statistically. Nevertheless the recombinant estimation method confirms our expectations built upon the theoretical model. The two mechanisms are significantly different in both sessions (at 7% in session 1, and at any usual significance level in session 2). As shown in the table the standardized bids mechanism

[27]Taking into account the suggestions by Mullin and Reiley (2006) we do not recombine observations across sessions or periods. Given the large number of possible groups we use a sample of 1,000 observations in the estimation of standard errors in the SB6 treatments. All other recombinant estimates are based on all possible groups.

outperforms the plurality voting scheme in realized efficiency.[28] When looking at the data with the original 8 and 3 groups, the only significant difference that we can find is between the PV and the SB6 treatments (in both sessions). However, according to the recombinant method the difference between PV and SB are significant at the usual significance levels. In the standardized bids mechanism as the number of participants increases, the proportion of ex post efficient decisions also increases, but these increments are not significant. As the plurality voting scheme only considers the most voted project and voters can not reveal information about the intensity of their preferences, it may select a non-efficient public project. Under the plurality voting scheme it occurred in 22% and 23% of the cases (in sessions 1 and 2 respectively) that subjects were voting truthfully but the mechanism did not manage to select the efficient alternative. With the standardized bids scheme this happened in 17% and 16% of the cases with group size of 3, and in 20% and 26% of the cases with groups of 6.[29] However, the differences between these proportions—except for the ones between the plurality vote and the standardized bids scheme in session 2—are statistically not significant. As table 7 reports it, the recombinant method shows a sharper image. Differences between PV and SB3 are significant at 2% in session 1, and at any usual significance level in session 2. The difference between treatments SB3 and SB6 has the expected sign in both sessions and is significant at 4%. Comparing the experimental results with the expected—simulation—results shown in table 5 one can see that in the lab both mechanisms performed very close to our expectations assuming truthful behavior. The above reported difference already confirms that the tension between the minority and the majority is present also in the computer lab, and that the standardized bids mechanism is able to reduce the edge of the conflict and increase efficiency.

The last row in table 6 shows the correlation between private valuations and votes/bids for the six treatments. As argued in the previous section this measure can be used as a proxy for efficiency. Note that the lower values in table 6 when compared to the corresponding columns in table 1 are fundamentally due to the presence of untruthful behavior and preference manipulation in the lab. The numbers are in line with our conjectures about the efficiency of the two mechanisms. Nevertheless the correlation in session 2 for the standardized bids mechanism

[28] Realized efficiency is the efficiency index that compares the aggregated value of the chosen project to the social value of the efficient one.

[29] In these cases we refer to reports that rank projects truthfully.

with group size 6 is surprisingly low. In the next subsection we turn our attention to individual bidding behavior, which offers more insight into individual behavior behind these facts.

6.2 Bidding behavior

Although the plurality voting protocol may have untruthful equilibria as illustrated in example 1, given the symmetric setup that we implemented in treatment 1 voting for the project with the highest personal valuation is a weakly dominant strategy. As for the standardized bids mechanism, unfortunately we do not have theoretical results on its Bayes Nash equilibria, but we do know from proposition 1 that these equilibria involve a truthful ranking of the available projects. In table 10 we report the observed voting/bidding functions for every treatment. The first three columns contain the argument of these functions, i.e. the private valuations for the projects, while the other groups of columns report the mean vote/bid for the given project. These estimates indeed constitute truthful rankings, as a project with a strictly higher valuation never receives smaller(less) bids(votes).[30] It is important to point out that in treatments with the standardized bids mechanism we set a minimum of 0 and a maximum of 100 for the value of admissible bids. Even though standardization makes standardized bids have the same magnitude, and it was explicitly written in the instructions, subjects often assigned the highest admissible value to their *favorite* project. With the data in our hand we can not tell whether this fact is explained by the wish of exaggerating on the positive effects of the personally *favorite* project, or subjects found it more comfortable to think and bid on the 0 - 100 scale than on any other.

Figure 1 shows the average range of bids for each subject in the standardized bids mechanism treatments.[31] These ranges show more variation across subjects than across treatments. If we consider all individual bids before standardization it turns out that their minimum falls between 0 and 5 in 48% of the cases (80% is between 0 and 40), while their maximum is between 95 and 100 in 62% of the cases (83% is between 60 and 100).

Table 8 reports the proportion of truthful ranking reports for each subject and treatment. When considering the entire subject pool the proportion of such reports is above 88% with

[30]In our experiment with only three possible values as private valuations ties are quite frequent. It is interesting that even if we have a relatively small data set projects with the same private value tend to receive votes/bids of the same magnitude.

[31]The order of subjects reflects decreasing variance in bids.

no significant difference across treatments. In both sessions there are 11 subjects who always sent truthful ranking as a message with their votes/bids.[32] If we consider the three treatments of session 1 together subjects—with two important exceptions—handed in truthful ranking in more than 80% of all cases. Subjects 20 and 21 stayed well below this level with 56% and 58%. Similarly, subjects 7, 8 and 20 in session 2 did not achieve more than 53%. We can not find any plausible explanation for their deviation from the predicted behavior as under incomplete information preference manipulation can not be justified in a rational way, and therefore we consider them outliers.[33] One could identify different outliers in different treatments, but that would not change our conclusions substantially. Moreover we believe that across-treatment comparisons are more adequate when the same subject pool is considered, although excluding these subjects would improve the statistical significance of our results.

Inspired by Rubinstein (2006) that finds that choices made instinctively require less response time than choices based on cognitive reasoning, we checked how much time did participants spend choosing their votes/bids in each treatment. Table 9 reports the mean response times for every treatment and session. We also split the subject pool according to their truthfulness in the observed bidding behavior.[34] While there are significant differences in the mean response time across treatments, there is no significant difference in the response time between the two groups of participants according to truthfulness.

Finally, let us take a look at standardized bids. Even in the absence of sound theoretical results about the precise form of the equilibrium bidding function, computer simulation gives us an idea of what message vector maximizes expected utility of the agents. In table 10 we include the expected (simulated) and observed standardized bids for the standardized bids treatments. In the simulation, we used the normal distribution with parameters estimated from our data as the distribution of the others' aggregated bid[35], and also made the assumption that the identity of the project is not important, that is as long as private valuations do not change agents use the same bids if we change the labels of the projects.[36] In summary, our experimental results

[32] We had completely different subject pools in the two sessions. Having 11 truthful participants is a coincidence or might reflect the characteristics of the larger (student) population.

[33] They might have failed to understand the instructions and did not ask for clarification.

[34] Our data suggested to use 70% as a cutoff, but our findings are not sensitive to this decision.

[35] This simplification makes the maximization problem easier, moreover the hypothesis of the normality of empirical distribution cannot be rejected at the usual significance levels.

[36] In case of complete indifference, i.e. if the vector of private valuations is $\{0;0;0\}$ or $\{10;10;10\}$ or

prove that even if individual messages differ from private valuations, reported rankings tend to be truthful in the vast majority of the cases, and also the observed standardized bids reflect the expected bidding behavior.

7 Concluding remarks

In this paper we have introduced a new rated voting scheme, the mechanism of standardized bids, and have made the first steps to study its performance both theoretically and experimentally. Its features look promising, nevertheless we plan to perform more research and run further experiments in order to place the standardized bids scheme in the list of existing mechanisms in the literature. In particular, experiments with an asymmetric setup and/or complete information could shed more light on strategic voting, i.e. on the manipulability of the standardized bids mechanism.[37] Additional data may help increase the significance and robustness of our findings, and could compare our proposal to other closely related voting rules, such as the Borda count or the quantitative voting scheme.

Another interesting line of research that we have not explored yet would consider the difficulty of manipulation in the standardized bids mechanism. As impossibility results like the Gibbard-Satterthwaite theorem show that when there are three or more candidates, all reasonable voting rules are manipulable, recent research has investigated whether it is possible to make finding a beneficial manipulation computationally hard.[38] This feature could circumvent the impossibility result in real life applications, because mechanism with simple rules whose Bayes Nash equilibria are hard, or even impossible to find may still induce the use of straightforward naïve strategies and good empirical performance.

$\{50; 50; 50\}$, any message can be accepted as a best response.

[37]In the asymmetric setup some people consistently care more about a given outcome. This has been recently studied by Jackson et al. (2007) in the context of political nominations. They discuss three different processes by which political parties nominate candidates (nominations by party leaders, nominations by a vote of party members, nominations by a spending competition among potential candidates). They show that more extreme outcomes can emerge from spending competition than from nominations by votes or by party leaders, and that non-median outcomes can result via any of these processes.

[38]Check for example Bartholdi et al. (1989).

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8 Proofs

Proof. (Proposition 1.) When choosing their strategies agents consider how individual bids influence the probability of any project j being chosen. Let us consider agent i's decision problem in order to solve the problem for equilibrium behavior.

As the messages sent by agents in the mechanism must meet the first two moment conditions, their distribution reflects the underlying distribution that characterizes uncertainty. The probability of project j being chosen can be written as:

$$\begin{aligned} Pr(j &\in argmax_{k\in P} Y^k) = Pr(Y^j \geq Y^1, Y^j \geq Y^2, ..., Y^j \geq Y^m) = & (5)\\ &= Pr(y_i^j + Y_{-i}^j \geq y_i^1 + Y_{-i}^1, y_i^j + Y_{-i}^j \geq y_i^2 + Y_{-i}^2, ..., y_i^j + Y_{-i}^j \geq y_i^m + Y_{-i}^m), & (6)\end{aligned}$$

where $Y_{-i}^j = \sum_{l\neq i} y_l^j$. Now assume that the number of problems linked together, m, is large. In this case, if other agents were truthful their messages, the y_{-i}^j's, would be approximately independently distributed over agents and decision problems.[39] Moreover and due to the central limit theorem, as the number of agents grows beyond any limit, the distribution of Y_{-i}^j gets close to normal.[40] Before proceeding to the study of the equilibrium behavior an important comment is in order: given that individual messages must meet the first two moment conditions no standardization is required, and the asymptotic distribution of Y_{-i}^j will be normal, $N[(n-1)\mu; (n-1)\sigma^2]$, for all i and j. Therefore,

$$Pr(j \in argmax_{k\in P} Y^k) \approx \Phi(y_i^j - y_i^1) \cdot \Phi(y_i^j - y_i^2) \cdot ... \cdot \Phi(y_i^j - y_i^m), \quad (7)$$

where Φ denotes the distribution function of the normal distribution with mean 0, and variance $2(n-1)\sigma^2$. Hence agent i's decision problem can be formally summarized by the following maximization problem:

$$max_{\{y_i^j\}_{j=1}^m} \sum_{j=1}^{m} x_i^j \cdot Pr(j \in argmax_{k\in P} Y^k) \quad (8)$$

[39]This fact allows for a huge simplification it the methodology, yet it is fairly unclear whether it is true or not. It requires careful study.

[40]Certain regularity conditions must hold for this to be true.

such that equations/conditions 1 and 2 hold. It turns out that that the solution to the maximization problem in equation 8 preserves the truthful ranking of the decision problems.

Let us prove the proposition by contradiction. Assume that $\{y_i^{j*}\}_{j=1}^m$ solves agent i's maximization problem, but there exist j and k such that $x_i^j > x_i^k$ and $y_i^{j*} < y_i^{k*}$ hold. The objective function under the *optimal* solution can be written as:

$$v(y_i^{j*}, y_i^{k*} \mid x_i^j, x_i^k) = ... + x_i^j \cdot \Phi(y_i^{j*} - y_i^{1*}) \cdot ... \cdot \Phi(y_i^{j*} - y_i^{m*}) + \\ + x_i^k \cdot \Phi(y_i^{k*} - y_i^{1*}) \cdot ... \cdot \Phi(y_i^{k*} - y_i^{m*}) + ... \tag{9}$$

Now let us consider an alternative solution, based on the previous one, under which agent i switches her bids for projects j and k. The value of the objective function in this case is:

$$v(y_i^{k*}, y_i^{j*} \mid x_i^j, x_i^k) = ... + x_i^j \cdot \Phi(y_i^{k*} - y_i^{1*}) \cdot ... \cdot \Phi(y_i^{k*} - y_i^{m*}) + \\ + x_i^k \cdot \Phi(y_i^{j*} - y_i^{1*}) \cdot ... \cdot \Phi(y_i^{j*} - y_i^{m*}) + ... \tag{10}$$

The difference between equations 9 and 10 is negative, that contradicts to the fact of $\{y_i^{j*}\}_{j=1}^m$ being an optimal solution the the maximization problem. In order to see that, consider (9)-(10):

$$v(y_i^{j*}, y_i^{k*} \mid x_i^j, x_i^k) - v(y_i^{k*}, y_i^{j*} \mid x_i^j, x_i^k) = (x_i^j - x_i^k) \cdot \Phi(y_i^{j*} - y_i^{1*}) \cdot ... \cdot \Phi(y_i^{j*} - y_i^{m*}) + \\ + (x_i^k - x_i^j) \cdot \Phi(y_i^{k*} - y_i^{1*}) \cdot ... \cdot \Phi(y_i^{k*} - y_i^{m*}) \tag{11}$$

Note that the first terms of the two elements in the sum coincide in absolute value. The first one is positive, while the second one is negative. As for the probabilities that weight these terms, since the distribution function Φ is increasing we have that $\Phi(y_i^{j*} - y_i^{l*}) < \Phi(y_i^{k*} - y_i^{l*})$ for all $l = 1, 2, ..., m$. □

9 Tables

Table 1: Correlation between private valuations and truthful messages for different number of available projects and types of uncertainty. PV: plurality voting; SB: standardized bids; $U[-1;1]$ and $U[0;1]$: uniform distribution; $N(0;1)$: standard normal distribution.

	$U[-1;1]$ and $U[0;1]$					$N(0;1)$				
m	2	3	5	10	20	2	3	5	10	20
PV	.58	.61	.58	.47	.36	.56	.60	.58	.51	.42
SB	.58	.74	.86	.94	.97	.56	.72	.84	.92	.96

Table 2: Proportion of ex post efficient decisions (%) for different number of available projects and agents assuming truthful behavior. PV: plurality voting; SB: standardized bids; $U[-1;1]$ and $U[0;1]$: uniform distribution; $N(0;1)$: standard normal distribution.

		$U[-1;1]$ and $U[0;1]$					$N(0;1)$				
	$n\backslash m$	2	3	5	10	20	2	3	5	10	20
PV	2	75	64	52	38	27	75	64	54	43	35
	3	84	71	54	35	22	84	70	55	40	28
	5	82	68	54	35	21	82	67	56	40	27
	10	79	69	52	33	20	78	67	53	37	26
	20	79	68	52	32	19	79	67	52	36	24
	100	81	68	51	31	17	79	67	51	34	21
SB	2	75	83	89	94	96	75	81	85	88	91
	3	84	83	86	90	93	84	81	82	85	88
	5	82	81	84	88	91	82	79	80	83	86
	10	79	80	83	87	90	78	78	79	82	85
	20	79	81	83	87	89	79	78	79	81	84
	100	81	80	83	86	89	79	78	79	81	84

Table 3: Realized efficiency (%) for different number of available projects and agents assuming truthful behavior. PV: plurality voting; SB: standardized bids; $U[0;1]$: uniform distribution.

		$U[0;1]$				
	$n\backslash m$	2	3	5	10	20
PV	2	94.0	92.2	90.0	86.9	84.1
	3	97.8	94.8	91.0	86.2	82.1
	5	98.0	95.5	93.3	88.5	83.3
	10	98.0	96.9	94.5	90.7	86.8
	20	98.6	97.6	95.8	92.6	89.3
	100	99.4	98.9	97.9	96.1	94.3
SB	2	94.0	97.4	99.1	99.8	99.9
	3	97.8	98.2	99.1	99.7	99.9
	5	98.0	98.4	99.2	99.7	99.9
	10	98.0	98.8	99.4	99.7	99.9
	20	98.6	99.1	99.5	99.8	99.9
	100	99.4	99.6	99.8	99.9	99.9

Table 4: Treatment summary. Trial periods between parenthesis. PV: plurality voting; SB: standardized bids.

	mechanism	periods	group size	projects
Session 1				
treatment 1	PV	(1) + 7	3	3
treatment 2	SB	(1) + 10	3	3
treatment 3	SB	(1) + 10	6	3
Session 2				
treatment 1	SB	(1) + 15	3	3
treatment 2	SB	(1) + 15	6	3
treatment 3	PV	(1) + 15	3	3

Table 5: Expected results per treatment based on computer simulation. PV: plurality voting; SB: standardized bids, groups size between parenthesis. Efficiency computed using the hypothesis of truthful behavior. Correlation between private valuations and votes/bids.

	$\{0;10;50\}$		
	PV	SB (3)	SB (6)
ex post efficient decisions	65%	75%	77 %
realized efficiency	91%	96%	96%
correlation	0.44	0.66	0.66

Table 6: Summary of experimental results. PV: plurality voting; SB: standardized bids; groups size between parenthesis. (rec.): estimates based on the recombinant technique. Correlation between private valuations and votes/bids.

	Session 1			Session 2		
	PV	SB (3)	SB (6)	PV	SB (3)	SB (6)
ex post efficient decisions	68%	79%	79%	71%	73%	72%
ex post efficient decisions (rec.)	61%	71%	70%	44%	61%	66%
realized efficiency	86%	91%	94%	87%	88%	92%
realized efficiency (rec.)	86%	91%	94%	75%	86%	92%
correlation	0.49	0.68	0.67	0.49	0.60	0.24

Table 7: Minority vs. majority. Proportion of inefficient decisions in spite of truthful rankings per session and treatment. (rec.): estimates based on the recombinant technique. PV: plurality voting; SB: standardized bids, groups size between parenthesis.

	PV	SB (3)	SB (6)
Session 1	22%	17%	20%
Session 2	23%	16%	26%
Session 1 (rec.)	33%	25%	19%
Session 2 (rec.)	48%	26%	22%

Table 8: Proportion of truthful ranking reports per session and treatment. PV: plurality voting; SB: standardized bids, groups size between parenthesis.

	PV	SB (3)	SB (6)
Session 1	91%	93%	91%
Session 2	92%	84%	88%

Table 9: Proportion of truthful ranking reports and mean response time (seconds) per session and treatment. PV: plurality voting; SB: standardized bids, groups size between parenthesis.

Proportion of	Session 1				Session 2			
truthful ranking reports	PV	SB (3)	SB (6)	Total	PV	SB (3)	SB (6)	Total
$\geq 70\%$	22.1	27.9	23.6	24.8	13.0	26.2	19.7	19.6
$< 70\%$	18.0	24.8	26.4	24.1	11.7	24.3	19.2	17.7

Table 10: Observed and expected standardized bids in the standardized bids treatments assuming that the identity of the project is irrelevant. Observed bids are estimated from the data by imposing the first two moment conditions. Expected standardized bids are simulated best responses to the observed distribution of others' bids. SB: standardized bids, groups size between parenthesis.

			Sessions 1 and 2											
			SB (3)						SB (6)					
Valuations			Observed			Expected			Observed			Expected		
Pr.1	Pr.2	Pr.3	Pr.1	Pr.2	Pr.3	Pr.1	Pr.2	Pr.3	Pr.1	Pr.2	Pr.3	Pr.1	Pr.2	Pr.3
0	0	0	-1.10	-0.22	1.32	*	*	*	-0.63	-0.78	1.41	*	*	*
0	0	10	-0.75	-0.67	1.41	-0.71	-0.71	1.41	-0.81	-0.60	1.41	-0.71	-0.71	1.41
0	0	50	-0.77	-0.64	1.41	-0.71	-0.71	1.41	-0.69	-0.73	1.41	-0.71	-0.71	1.41
0	10	0	-0.77	1.41	-0.65	-0.71	1.41	-0.71	-0.63	1.41	-0.78	-0.71	1.41	-0.71
0	10	10	-1.41	0.70	0.71	-1.41	0.71	0.71	-1.40	0.55	0.85	-1.41	0.71	0.71
0	10	50	-1.04	-0.31	1.35	-0.79	-0.62	1.41	-0.96	-0.42	1.38	-0.86	-0.54	1.40
0	50	0	-0.85	1.40	-0.56	-0.71	1.41	-0.71	-0.68	1.41	-0.73	-0.71	1.41	-0.71
0	50	10	-0.97	1.38	-0.41	-0.79	1.41	-0.62	-1.41	1.32	-0.23	-0.86	1.40	-0.54
0	50	50	-1.41	0.69	0.73	-1.41	0.71	0.71	-1.41	0.80	0.61	-1.41	0.71	0.71
10	0	0	1.41	-0.84	-0.56	1.41	-0.71	-0.71	1.41	-0.79	-0.62	1.41	-0.71	-0.71
10	0	10	0.69	-1.41	0.73	0.71	-1.41	0.71	0.55	-1.40	0.86	0.71	-1.41	0.71
10	0	50	-0.45	-0.94	1.39	-0.62	-0.79	1.41	-0.41	-0.96	1.38	-0.54	-0.86	1.40
10	10	0	0.70	0.72	-1.41	0.71	0.71	-1.41	0.87	0.53	-1.40	0.71	0.71	-1.41
10	10	10	0.42	0.96	-1.38	*	*	*	-1.39	0.46	0.93	*	*	*
10	10	50	-0.68	-0.73	1.41	-0.71	-0.71	1.41	-0.70	-0.72	1.41	-0.71	-0.71	1.41
10	50	0	-0.38	1.37	-0.99	-0.62	1.41	-0.79	-0.53	1.40	-0.87	-0.54	1.40	-0.86
10	50	10	-0.69	1.41	-0.72	-0.71	1.41	-0.71	-1.01	1.36	-0.35	-0.71	1.41	-0.71
10	50	50	-1.41	0.79	0.62	-1.41	0.71	0.71	-1.38	0.96	0.42	-1.41	0.71	0.71
50	0	0	1.41	-0.78	-0.64	1.41	-0.71	-0.71	1.39	-0.49	-0.91	1.41	-0.71	-0.71
50	0	10	1.35	-1.05	-0.30	1.41	-0.79	-0.62	1.39	-0.92	-0.47	1.40	-0.86	-0.54
50	0	50	0.67	-1.41	0.74	0.71	-1.41	0.71	0.93	-1.39	0.46	0.71	-1.41	0.71
50	10	0	1.36	-0.35	-1.01	1.41	-0.62	-0.79	1.40	-0.54	-0.86	1.40	-0.54	-0.86
50	10	10	1.41	-0.83	-0.58	1.41	-0.71	-0.71	1.41	-0.57	-0.84	1.41	-0.71	-0.71
50	10	50	0.82	-1.41	0.59	0.71	-1.41	0.71	0.76	-1.41	0.65	0.71	-1.41	0.71
50	50	0	0.79	0.62	-1.41	0.71	0.71	-1.41	0.84	0.57	-1.41	0.71	0.71	-1.41
50	50	10	0.84	0.56	-1.41	0.71	0.71	-1.41	0.74	0.67	-1.41	0.71	0.71	-1.41
50	50	50	1.11	-1.31	0.20	*	*	*	1.14	-1.29	0.15	*	*	*

Figure 1: Distribution of bids in the standardized bids game. The average maximum, minimum and mean (indicated with the square) bid. Subjects ordered according to the variance of their bids.