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Community Projects:
An Experimental Analysis of a Fair Implementation Process

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Abstract

We define and experimentally test a public provision mechanism that meets three basic ethical requirements and allows community members to influence, via monetary bids, which of several projects is implemented. For each project, participants are assigned personal values, which can be positive or negative. We provide either complete or only private information about others' personal values. This produces two distinct public provision games which are experimentally implemented and analysed for various projects. In spite of the complex experimental task, participants do not rely on truth-telling as an obvious and simple heuristic whose general acceptance would result in fair and efficient outcomes. Rather, they yield to strategic underbidding. Although underbidding is affected by projects' characteristics, the provision mechanism seems quite functional.

JEL classification: C91; C72; D63.

Keywords: Public Provision, Procedural Fairness, Experiment.

1 Introduction

Starting with the seminal work of Rapoport and Chammah (1965) on the Prisoner's Dilemma, the provision of public goods has been widely investigated in experimental settings. Generally, participants in a public goods game are asked to contribute to a public good that generates positive externalities for all those in the group of potential contributors, irrespectively of the actual amount contributed (Bergstrom *et al.*, 1986). In this kind of setting, the public good generates benefits to everyone. Furthermore, the size of benefits seems to positively affect the likelihood of contribution to the public good (see, for a review, Ledyard, 1995). In an attempt to more closely reflect reality, both heterogeneity in the valuations of the good across different participants (e.g., Bagnoli and McKee, 1991; Rondeau *et al.*, 1999) and negative spillovers were experimentally investigated (e.g., Andreoni, 1995; Sonnemans *et al.*, 1998). However, the type of spillovers originating in the public goods, either positive or negative, was kept the same for all participants. Our paper extends the framework of public goods games and experimentally investigates a fair procedure for the implementation of projects that may benefit one party but harm another party. Projects of this kind are frequently observed in the real world and may give rise to the so-called NIMBY syndrome.[1] As an example, the building of a new railroad may benefit the traders in the community but, at the same time, may damage the farmers whose land is needed to build the railroad.

Following Güth *et al.* (2011), we label projects that may harm some and benefit others "mixed-feelings" projects. Güth *et al.* (2011) show that mixed feelings do not negatively impact the capacity of players to choose the most efficient project in a competition among a traditional public good and a more efficient public project raising mixed feelings. In other words, participants proved able to select the most efficient project, and where the project was not implemented,

[1] The acronym NIMBY stands for "Not In My Backyard" and identifies projects that are likely to improve general welfare, but generate costs for the individuals living close to the project who, as a consequence, oppose the implementation of the project (e.g., Frey and Oberholzer-Gee, 1997).

it could be attributed to co-ordination failure rather than to the presence of mixed feelings.

In the presence of mixed feelings, it is essential that the rules governing the choice and the allocation of the surplus from the project are fair. Güth and Kliemt (2011) elaborate an axiomatic characterisation of a procedurally fair institution that constitutes the game form that will be applied in this paper, like in Güth *et al.* (2011). Individuals involved in decision-making within this institution are called on to bid on the provision of a set of projects, whose provision points are publicly known. Through their bids, participants state the maximum contribution they are willing to make to the project given the information they have available. The bids can also be negative and, if low enough, veto the implementation of the project. Assuming the common measuring rod of money for whatever the concerns are, fairness is intended with respect to the public and observable bids. The fairness condition implies that participants should get the same benefit with respect to their bids from implementation. The "status quo" is maintained when the bids do not justify provision, whereas when bids render implementation justifiable, the most efficient set of projects is selected.

Compared to Güth *et al.* (2011) we investigate mixed feelings in a much richer experimental setting and bring the analysis closer to the field applications of a small community.[2] In our three-player setting there are seven alternative projects, whose costs are commonly known. Unlike Güth *et al.* (2011), we do not focus on competition between traditional public goods and projects raising mixed feelings. Rather, we study how variation in induced values impacts bidding and provision. To elaborate, five different sets of personal values and costs (i.e., prospects) are constructed in order to test the impact of different personal values, of negative personal values, and of the social benefit generated by the bids.

According to our results, all these factors affect the general underbidding

[2]Güth *et al.* (2011) test the simplest case of two players and two projects, with one player always having higher values than the other for both projects, and compare bids and provision rates for the case of one traditional public good project with those of a public project raising mixed feelings.

tendency and, in turn, the creation of surplus. We analyse the extent to which participants succeed in coordinating on the provision of the most efficient public project. Variance in personal values may explain failures to provide the most efficient project because it inhibits coordination around bids that ensure implementation. Evidence collected shows that in Prospect 4, in which all induced values are the same, the most efficient project has the highest implementation rate across all prospects. Thus, it seems that efficiency losses in the provision are, at least partly, due to differences in personal values.

In order to check how the difference between the sum of personal values and costs (i.e., social benefit) affects behaviour, we distinguish two information settings: in both, participants know the project costs, but in one they are aware only of their own personal values (private information setting), whereas in the other they also know others' personal values (public information setting). From evidence collected, we conclude that common knowledge of others' evaluations does not substantially impact bidding behaviour and project implementation. When deciding how much to bid, participants seem to focus on their own evaluation of the projects.

The paper is organised as follows: Section 2.1 presents the theoretical basis (game format) underlying the experiment; Section 2.2 and Section 2.3 outline the experimental design and the behavioural predictions, respectively; Section 2.4 describes the procedure followed to conduct the experiment; Section 3 presents the results of the experiment; Section 4 discusses and concludes.

2 Method

2.1 The Game Format

Participants $i \in N = \{1, \ldots, n\}$ with $n \geq 2$ are attributed personal values for each different combination (subset) S of a certain finite number of possible

measures Ω.[3] Personal values measure the pleasure or displeasure for each participant in case the subset is implemented. To illustrate this point, take the example of a community that is made up of families living in a block of flats. A family living on the third floor will benefit more from a lift than a family living on the ground floor. In our experiment this will be translated in a higher personal value for the family living on the third floor.

Based on her personal values $v_i(S)$, each participant $i \in N$ is asked to make a bid $b_i(S)$ for each possible subset. Each subset is associated with implementation costs $(C(S))$.[4] The overall benefit to the community (social benefit) is captured by the difference between the sum of the personal values and the cost. Implementation, however, relies on bids rather than personal values. Only when the surplus, i.e. the sum of the bids minus costs, is non-negative, a project might be implemented. However, only the most efficient subset S^* with respect to surplus, i.e. the subset maximising participants surplus $\sum_{i=1}^{n} b_i(S) - C(S)$, will be selected for implementation. Based on the bids and the surplus, each participant will be asked to make a payment.

If $S^* \neq \emptyset$, denote by $p_i(S^*)$ the payment required from each $i \in N$. The payoff π_i for participant i will be defined as the difference between her personal value and her payment for the selected subset: $\pi_i = v_i(S^*) - p_i(S^*)$.

Three axioms determine the game format.

Axiom 1 *Efficiency with respect to bids*

If $\forall\ \emptyset \neq S \subset \Omega$,
$\sum_{i=1}^{n} b_i(S) < C(S)$, *then* $S^* = \emptyset$
Otherwise, $\forall\ S \subset \Omega$
$\sum_{i=1}^{n} b_i(S^*) - C(S^*) \geq \sum_{i=1}^{n} b_i(S) - C(S)$.

The sum of all participants' bids for a certain subset of measures must be

[3] Framing different projects S as different non-empty subsets is one possibility to generate different project alternatives S. In our experiment we quite arbitrarily define different alternatives S rather than deriving them as such subsets of single projects which may be substitutes or complements.

[4] Costs could be negative, for example, when implementation is generating revenues rather than costs. However, this possibility is neglected here.

equal or higher than the costs of that subset; otherwise, the subset is not implemented. Only one subset S^* is selected among those for which the bids at least cover the costs, namely the one with the highest surplus.

Axiom 2 *Cost balancing*
$\sum_{i=1}^{n} p_i(S^*) = C(S^*)$

The sum of all payments for the chosen subset S^* should cover the costs.[5]

Axiom 3 *Equal payoff with respect to bids*
$b_i(S^*) - p_i(S^*) = b_j(S^*) - p_j(S^*) = \triangle$ *for all* $i, j = 1, \ldots, n$

The difference $\triangle$ between the bid and the actual payment, i.e., the players' payoff with respect to bids, must be the same for all participants. From these axioms it follows that the payment is given by the bid minus an equal share of the surplus. When bids do not cover the costs for any subset, then no subset will be implemented and participants incur no payment so that their payoffs are zero. Otherwise, for the selected subset S^* the payments are computed as follows. Axiom 3 implies $b_i(S^*) - p_i(S^*) = \triangle \in \mathbb{R}$ or $b_i(S^*) = p_i(S^*) + \triangle$ for all $i \in N$. Due to $\sum_{i=1}^{n} b_i(S^*) = \sum_{i=1}^{n} p_i(S^*) + n\triangle$ and $\sum_{i=1}^{n} p_i(S^*) = C(S^*)$, we obtain $\triangle = \Big(\sum_{j=1}^{n} b_i(S^*) - C(S^*)\Big)/n \geq 0$ and thus $p_i(S^*) = b_i(S^*) - \Big(\sum_{j=1}^{n} b_i(S^*) - C(S^*)\Big)/n$ for all $i \in N$, what shows that bids serve as upper bounds for payments.

The final payment is defined by the bid minus an equal share of the surplus. Thus, it does ultimately depend on the voluntary bids of the players.

2.2 Experimental Design

In the experiment, we are interested in studying how variations in the personal values affect bidding behaviour with respect to a baseline "prospect". Each prospect contains the costs (C) and personal values (v_1, v_2, v_3) for each of

[5] One could allow for taxing or subsidising public provision; for example in the form of $\sum_{i=1}^{n} p_i(S^*) + c = C(S^*)$ for some given $c \in \mathbb{R}$. As for negative costs, this possibility is neglected here.

seven subsets of measures. Hereafter, for simplicity, we refer to each subset of measures as a project. Table 1 provides a description of the 5 prospects implemented in our experiment. Participants are allocated to groups of 3. Each participant is asked to submit a bid (b) for each project in a prospect. The surplus (SP) of each project is defined as the difference between the sum of the bids for that project by the three participants in a group ($\sum_{i=1}^{3} b_i$) and the cost C of that project ($SP = \sum_{i=1}^{3} b_i - C$). The project with the highest surplus, when this is positive, is implemented. If the highest surplus is negative, no project is implemented. When a project is implemented, the payoff π_i of participant i is given by the difference between her personal value and her bid minus an equal share of the surplus created by the bids for the implemented project: $\pi_i = v_i - b_i + \frac{SP}{3}$ with $SP = \sum_{i=1}^{3} b_i(S^*) - C(S^*)$ for $i = 1, 2, 3$.

[Table 1 about here]

The values in prospects from 2 to 5 in Table 1 are obtained as variations of those in Prospect 1, which represents our reference prospect. In Prospect 2 the same social benefits as in Prospect 1 are obtained by an appropriate reduction of costs and personal values. The aim of this manipulation is to explore the impact of higher/lower values on bidding behaviour. In Prospect 3, measure A has negative values for all participants. The aim of this variation is to check the impact of negative values on behaviour. In Prospect 4, all participants have the same positive personal values. This way we aim to check for the impact of a lack of mixed feelings and equal personal values. Finally, in Prospect 5 two projects (AB and BC) generate high social benefits, with project BC being the most efficient in terms of social benefits, and AB being the second most efficient, with a social benefit equal to the highest social benefit in the other prospects.

Two alternative experimental treatments were implemented in a between-subjects design, with both providing commonly known costs. In one condition participants were informed only of their own personal values (*Private information*). In the alternative condition participants were informed also of the

personal values of the other two in the group (*Public information*). In the latter participants are aware of the social benefits.

2.3 Behavioural Predictions

The institution we experimentally investigate is based on three axioms leading to a fair and efficient outcome with respect to bids. Fairness is defined with reference to the bid (procedural fairness); it can lead to different payoffs per participant, i.e., it does not necessarily lead to fair and efficient actual outcomes. However, if all participants bid their personal values, the payoffs are equal. Thus, general truth-telling would generate a "fair and efficient outcome" both with respect to bids and with respect to personal values. Hence, this is a possible benchmark to start from. The same outcome would be achieved if all participants under- or overbid by the same amount; this, however, seems rather unlikely. Hence, bidding exactly personal values seems to be the focal "fair" benchmark and a natural heuristic in such a complex experimental scenario.

However, bidding personal values is in general no (Nash) equilibrium.[6] If in Table 2 all bid their personal value this leads to a payoff per person of 6. However, in this situation, there are incentives for unilateral deviation and therefore, general truth-telling is not an equilibrium.

[Table 2 about here]

The bids determine the allocation of the social benefit in case of implementation, but not its size. In Table 2, where all participants bid their personal values, the payoffs are 6 for each participant (i.e., 1/3 of the surplus). Looking at Participant 1 (the same is true for the others), she has an incentive to lower her bid. If she lowers her bid from 12 to 0, the project would still be implemented but she would earn more, namely 12+2=14 instead of 6. Hence, underbidding leads to a larger payoff, taking other participants' behaviour as given. However, Participant 1 can do even better by bidding -6. In this case,

[6] Exceptional cases are when personal values add to the costs.

she would get all the social benefit. This clearly demonstrates that truth-telling is usually weakly dominated and that one should expect strategic underbidding (bid shading), similarly to what happens in experimental first-price auctions (Kagel, 1995).

More fundamentally, the experiment is as an exploratory study of a fair and efficient institution. The key objective is to learn about bidding behaviour in the institution and to verify whether applying the proposed mechanism provides the project that delivers the highest social benefit. We assume that participants will take their personal values as a reference for their bids. It is reasonable to expect underbidding, as this would increase the participant's payoff (see also Güth *et al.*, 2011); by contrast, overbidding is quite unlikely as it would decrease the participant's payoff in case of project implementation and can even lead to negative payoffs. The extent of underbidding can hardly be predicted before running the experiment, although we expect that knowing other participants' values will affect bidding behaviour. In the private information setting, participants only know their own personal value and the project cost; in the public information setting they have, in addition, information about the other participants personal values. Knowledge of other participants' values enables them to calculate the social benefit of each project, which renders implementation of the most efficient project more likely. We expect higher implementation rates of the most efficient projects in the public than in the private information setting.

However, the ability of participants to coordinate on the most efficient project in the absence of communication may be complicated by several factors. In the public information setting, their ability to compute the social benefits and to coordinate around bids that ensure implementation is likely to be related to the variance in personal values. When all participants are assigned the same positive value, it should be easier for them to predict other participants' behaviour and to coordinate on bids that ensure project implementation. More precisely, we expect bids to fall in the interval between bidding their personal

value and bidding an equal share of the project costs. Prospect 4 assigns all participants the same values; comparing the implementation rates of Prospect 4 with the other prospects allows us to test this hypothesis.

Highly unbalanced personal values render predictions about others' behaviour more difficult and bidding behaviour more variable. Relative to the case of equal personal values, the implementation of the most efficient project is expected to be negatively affected by the higher variability of bids. Prospect 5 contains the project that generates the highest social benefits in the experiment (AB). However, personal values for this project are more varied than those for the best project in Prospect 4. The comparison between implementation rates in the two prospects provides us with a measure of the impact of variance in personal values. Furthermore, Prospect 5 contains project AB that delivers a social benefit equal to the best one in the other prospects. The comparison between Prospect 5 and other prospects allows us to assess how the prominence of the most efficient project impacts its implementation.

Negative personal values are expected to have a stronger impact on bids and on the implementation than the corresponding positive values. Particularly in the private information setting, this is expected to lead to higher underbidding and may thus be expected to reduce the group's capacity to coordinate on the most efficient project. All prospects, with the exception of Prospect 4, contain negative values. Prospect 3 comprises the largest number of negative personal values.

We expect that the size of personal values influences bidding behaviour. However, the magnitude and direction of its effect could not be predicted prior to the experiment. Prospect 2 was specifically designed to shed light on the effect of the size of personal values.

2.4 Participants and Procedures

The Experiment was run in Jena (Germany) at the laboratory of the Max Planck Institute of Economics. Participants were recruited among students

of the Friedrich Schiller University of Jena using the ORSEE system (Greiner, 2004). The computerised experiment was programmed and conducted using the z-Tree software (Fischbacher, 2007). A total of 57 participants took part in two experimental sessions, with 30 participants in the public information condition and 27 in the private information condition.

Upon their arrival at the laboratory, participants were randomly allocated to cubicles inhibiting interaction with other participants. Each participant received written instructions and was invited to read them privately. After that, a member of staff read the instructions aloud and participants were given the opportunity to privately ask staff members for clarifications. The experiment started only after each participant had answered a control questionnaire checking for their understanding of the instructions.

Each participant in the experiment was exposed to all prospects and to all personal values of Table 1 over 15 independent rounds.[7] During the experiment participants received no feedback (about the project implemented or bids of others in the group). At the end of the experiment, one of the 15 rounds was randomly selected for the final payment and participants were informed about the project that was implemented and their payoff for that project. Payoffs in the experiment were added to a €5 show-up fee and payments were privately dispensed in cash at the end of the experiment. In the instructions, participants were remembered that earnings in the experiment could be negative. In case of negative earnings, the following procedure is followed: first, the show-up fee is used to cover the losses; second, when losses are bigger than the show-up fee, the participant could choose to pay the difference with her pocket money or to take part in a boring task (i.e., computing the frequency of letter "t" in a text). The length of the task is proportional to losses not covered by the show-up fee.

[7] A series of Wilcoxon Rank Sum tests reveals that rounds based on the same prospect can be pooled together.

3 Results

3.1 Bids

Figures 1 and 2 show the distribution of bids for each combination of prospects and projects in the private and public information condition, respectively. The boxplots in each cell provide the conventional representation of the distributions of bids for each personal value (identified by a full circle).

[Figure 1 about here]

In Figure 1, higher bids are observed in correspondence with higher personal values. Moreover, the distribution of bids tends to be asymmetrically distributed on values lower than personal values. This signals a tendency to underbid one's own personal value. This tendency seems to be stronger for higher (absolute) personal values.

[Figure 2 about here]

As highlighted by eyeballing and comparing Figures 2 and 1, introducing common knowledge of personal values does not heavily affect bidding behaviour. The same pattern of choices emerging for the private information condition is observed also for the public information condition.

3.2 Bids and Personal Values

Figure 3 provides a detailed representation of underbidding and focuses on relative deviations between bids and personal values. Specifically, a measure of relative deviation for each project (R_i) is computed by taking the ratio of the difference between the bid for a given project b_i and the personal value for that project v_i and the absolute value of the personal value ($R_i = \frac{b_i - v_i}{|v_i|}$). Figure 3 portrays the distribution of the individual-level average R_i, in the five distinct prospects of the private information and public information condition.

[Figure 3 about here]

Figure 3 confirms the prevalence of underbidding in participants' behaviour. The distributions of relative deviations are generally located under the threshold (dashed line) separating overbidding from underbidding, both in the public and private information conditions. When comparing the two information conditions, no major differences are observed. The average relative deviations in the two conditions are very similar (continuous line) and no significant differences are observed when comparing the two conditions prospect by prospect (Wilcoxon Rank Sum tests, all p-values> 0.1).[8]

A series of Wilcoxon Signed Rank tests highlights some significant differences in relative deviations across distinct prospects. In the private information condition, underbidding is stronger for Prospect 2 than for all other prospects (all p-values < 0.05). In the public information condition, stronger underbidding is observed for Prospect 2 than for all other prospects (all p-values < 0.05), but Prospect 1 (p-value=0.171).

From Figure 3 it is obvious that truth-telling (in the sense of bidding personal values throughout) is hardly ever observable. Thus, hoping that in such a complex experiment one will rely on truth-telling as a simple and obvious heuristic cannot be confirmed. Rather, participants seem to recognise the underbidding incentives of the mechanism.

3.3 Implemented Projects

The analysis above shows that participants tend to post bids that are lower than their personal values. Behaviour of this kind negatively affects the creation of surplus and may endanger the implementation of projects. Figure 4 provides a comparison between the average surplus and the social benefit of each project in the two information conditions.

[Figure 4 about here]

[8] To warrant independence of observations, the tests in this section are performed employing average values at the individual level.

As Figure 4 shows, the strong underbidding observed in the experiment negatively affects the creation of a positive surplus, even for projects delivering positive social benefits. In terms of surplus creation, no major differences are observed between the public and private information conditions. To complement the analysis of surplus creation, Table 3 reports on the frequency of implementation of each project. The frequencies in the table are computed taking into account all possible combinations of bids collected for that project in each round, irrespectively of the group to which participants belonged.[9]

[Table 3 about here]

Table 3 shows that for each prospect, the project delivering the highest social benefit is the project most frequently implemented, both in the public and private information conditions. The highest frequency of implementation for the socially most desirable projects is registered in Prospect 4, for both information conditions. In contrast, the lowest frequency of implementation for these projects is registered in Prospect 2 and in Prospect 5 for the private and public information condition, respectively. As regards difficulties to implement any project, the highest rate of failure is registered in Prospect 3 for both information conditions.

When comparing the frequency of implementation of the most efficient project across information conditions, no significant differences emerge (Wilcoxon Rank Sum tests, all p-values > 0.255).[10] Similarly, no significant differences are observed when comparing the failure of implementation frequencies for all projects across the two conditions (Wilcoxon Rank Sum tests, all p-values > 0.289)

[9]Given that the participants did not receive any feedback during the experiment, groups do not affect choices over the course of the experiment. Consequently, a better measure of project implementation is obtained by taking into account all possible combinations of bids for a given project in a given round and not only the bids in each group of three participants. This implies that, in each round and for each project, 10^3 and 9^3 triplets of bids are obtained in the public and private information conditions, respectively.

[10]To warrant independence of observations, we computed the frequency of implementation of the socially most desirable projects at the group level for both information conditions. The difference in the central tendencies of the distributions thus computed was then tested with the support of a non parametric test. The same procedure was followed for the other tests reported in this section.

The comparison of implementation frequencies of the most efficient project across prospects highlights some significant differences. In the public information condition, we register highly significant differences when comparing Prospect 2 to Prospects 3 and 4 (Wilcoxon Signed Rank test, p-values equal to 0.031 and 0.021, respectively). Weakly significant differences are registered when comparing Prospect 4 to Prospect 1 and Prospect 5 (Wilcoxon Signed Rank test, p-values equal to 0.065 and 0.051, respectively). In the private information condition, we register a weakly significant difference when comparing Prospect 3 to Prospect 4 (Wilcoxon Signed Rank test, p-value equal to 0.072).

3.4 Regression Analysis

The descriptive analysis reported above underlines some patterns of behaviour with respect to bidding and project implementation. In this section, a regression analysis investigates the determinants of bidding behaviour, with particular attention paid to deviations from personal values. A better understanding of bidding behaviour provides us with insights about the source of surplus creation and project implementation.

Table 4 presents the results of a regression analysis based on a linear mixed-effects model with random effects to control for repeated observations at the individual level. The dependent variable in the model is the relative deviation of bids (b_i) from personal values (v_i) expressed in percentage terms, $Rel.dev_i = \frac{b_i - v_i}{|v_i|} \times 100$. A positive sign for the dependent variable identifies overbidding, while a negative sign identifies underbidding.[11] The dependent variable is regressed on the following explanatory variables: *Personal.value* is the personal value assigned to a subject for the project; *Project.cost* is the cost of the project; *Personal.values.SD* is the standard deviation of personal values for the project considered; *Personal.value.NEG* is equal to 1 if the personal value is negative, and is equal to 0 otherwise; *Soc.benefit* is the social benefit

[11] The dependent variable $Rel.dev_i$ cannot be computed for those having a personal value equal to zero. Accordingly, the regression analysis is conducted on 5757 observations out of the 5985 available.

and measures the efficiency of the project; *Public.info* is equal to 1 for the public information setting, and it is equal to 0 for the private information setting; *Round*, indicates in which of the 15 rounds choices were made. In addition to main effects, some interactions between explanatory factors are considered in the regression, with particular attention paid to the impact of public information. Finally, *Prospect #* provides us with a control on the prospect in which bids were collected.

[Table 4 about here]

The regression output reported in Table 4 confirms the overall tendency to underbid. Furthermore, a more aggressive underbidding is registered among those with negative personal values. When personal values fall in the positive domain, an increase in personal values reduces underbidding. By contrast, higher negative personal values trigger stronger relative underbidding. Both higher costs for the project and higher variance in personal values foster underbidding. Concerning the impact of information, common knowledge of others' values has a significant impact on bidding behaviour via awareness of the variance in personal values, but not via awareness of the social benefits generated by the projects. When compared to the baseline condition provided by Prospect 1, two prospects have a significant impact on relative deviations: Prospect 2 strongly promotes underbidding, while Prospect 4 mitigates deviations from personal values, even if only marginally significant.

The regression estimates of Table 4 allow us to predict relative deviations from personal values. In particular, it is possible to predict underbidding especially for the most efficient project in each prospect. For projects of this kind, the highest average relative deviation is registered in Prospect 2 (-46.6%), while the lowest one is that of Prospect 4 (-26.7%). The other average values are equal to -38.8%, -36.3%, and -40.4% for Prospects 1, 3, and 5, respectively. Thus, predictions for the most efficient projects are in line with the effects highlighted by the regression analysis: Prospect 2 further promotes underbidding, while the

opposite holds for Prospect 4.

4 Discussion and Conclusions

Based on three intuitive requirements for an ethically desirable mechanism to regulate public provision, we have derived a common game format. One could claim—using jargon of social psychology—that this game format is procedurally fair. As for procedurally fair sports contests, one can hope that this crowds-in material opportunism in the sense that the parties involved are mainly motivated by their own material, here monetary, incentives. Although truth-telling would seem an obvious simple heuristic to pursue own material interest, this is hardly ever observed. Rather, nearly all participants understood the incentives for strategic underbidding and yielded to them.

Our experimental setting allows us to identify a few project characteristics that affect underbidding and, as a consequence, creation of surplus. In particular, underbidding seems to be weaker for positive than for negative personal values. Moreover, higher positive personal values induce less relative underbidding, while the opposite holds for negative values. With respect to the impact of information, we observe that common knowledge of others' values induces more underbidding for a given level of dispersion in personal values. In terms of surplus creation, we do not observe strong differences when comparing the private and public treatments. In both, the most efficient project is the one most frequently implemented.

When assessing behaviour across prospects, a few patterns emerge. First, Prospect 4, characterised by homogeneous positive personal values, is the prospect that results in the best outcome in terms of implementation of the most efficient project. Second, in Prospect 5 there is a competing project which is similar in terms of social benefits to the most efficient project. This seems to negatively affect implementation of the most efficient project. Third, Prospect 2 provides a larger underbidding margin before endangering the implementation of projects

than other prospects.[12] Accordingly, participants underbid more, on average, in this prospect than in other prospects.

Altogether, heterogeneity in personal values and negative values seem to endanger implementation of efficient projects. Knowing the value of others does not seem to matter much as subjects mainly condition on their own value when bidding. Strong underbidding may imply that own socially beneficial projects are not implemented because the sum of the bids does not cover the cost. Thus, with heterogeneous personal values, projects with very high social benefits are less endangered by underbidding than projects with positive, but smaller, social benefits. Some inefficiency due to the difficulties to coordinate underbidding had to be expected since the mechanism, as characterised by the three axioms, is not incentive-compatible. Nevertheless, large social benefits serve as a safeguard by allowing provision even when community members underbid. We conclude that our experiment reveals some surprising practical functionality of the proposed implementation process: the mechanism guarantees citizen sovereignty in public provision, similar to what happens for private goods.

[12] As a measure of underbidding margin, we compute the relative underbid that when jointly implemented by a group generates nil surplus. In Prospect 2, the average underbidding margin across projects is equal to 0.339, while for other prospect the same measure is always smaller than 0.250.

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A Instructions (Translated)

Welcome to this experiment! You will receive €5.00 for showing-up on time.

We kindly ask you to read the instructions carefully. Communication with other participants is not permitted during the experiment. If you have doubts or if you want to ask a question, please raise your hand. An experimenter will come and answer your question. Please switch off your mobile phones. If you do not comply with these rules, we will have to exclude you from the experiment and you will not get any payment.

How much you are going to earn will depend upon your decisions and also upon decisions of other participants. Both your choices and choices of the others will remain anonymous and will never be associated to your name.

During the experiment, all monetary amounts are expressed in ECU (experimental currency units) and not in Euro. At the end of the experiment 1 ECU will be exchanged with 1 Euro.

In the experiment you are matched with two more participants whose identity will not be revealed. The three participants in a group are called Participant 1, Participant 2, and Participant 3. You will be told whether you are Participant 1, Participant 2 or Participant 3 in the upper right-hand corner of the screen.

The experiment extends over 15 rounds. At the end of the experiment, only one of the 15 rounds is randomly drawn to compute your actual earnings in the experiment.

The interaction in each round

In each of the 15 rounds, 7 projects with their corresponding costs and personal values are going to be displayed on your screen. The structure of the screen is the same in each round, but the costs and personal values associated with the different projects may vary in each round. Of the seven projects three are single projects and four are combinations of single projects. For each project you are given information about the cost associated with its implementation and about your personal evaluation of the project. The evaluation of the project is a positive number if you gain from its implementation and a negative number if you suffer a loss from its implementation. This number is called personal value (V_i). *[Public Information only] You are also informed about the personal values of the other two participants in your group.* Based on the information you are given, you are requested to submit a bid (b_i) for each project. Your bids and the bids of the two other participants in your group determine your payoff. Bids can be expressed only as integer values, either positive or negative (for example: ...,-1, 0, 1,...).

Payoffs

The surplus of each project is defined as the difference between the sum of the bids for that project by the three participants in a group ($b_1 + b_2 + b_3$) and the cost of that project (c). Thus, the surplus is given by the formula $S = (b_1 + b_2 + b_3) - c$.

The project with the highest non-negative surplus is implemented. If the highest surplus is negative, no project is implemented and your payoff will be 0 ECU.

When a project is implemented, the earnings of a participant are determined as follows:

- You receive your value (V_i) for the chosen project plus one third of the surplus of the chosen project ($S/3$)
- From this we subtract your bid for the chosen project
- Therefore you earn in total: $V_i + S/3 - b_i$

The following is an example of the kind of computer screen you will see during the experiment:

Project	Cost	Personal value (participant 1)	Personal value (participant 2)	Personal value (participant 3)	My bid
A	15	-12			
B	5	13			
C	7	-9			
A,B	19	3			
A,C	23	-18			
B,C	13	5			
A,B,C	25	-7			

In the Public Information condition the values of the other participants are displayed on the screen.

Suppose you are Participant 1 and consider your choice for project A. If the project were implemented, it would cost 15 ECU. You have a negative personal value for the project (-12). If the project were implemented, you would suffer a damage of 12 ECU. You must bid for the project. The amount you bid is relevant for the implementation of the project and for the amount you will have to pay or you will receive if the project is implemented. Suppose that the overall surplus of this project amounts to 30 ECU and that this is the highest surplus. This means that Project A is implemented. Each participant gets an equal share of the surplus thus, each member of the group receives 10 ECU. If you bid -14 ECU for the project, your payoff is calculated as follows: -12 + 10 - (-14) = 12. It is made up of the following elements: in your role as Participant 1, you will suffer a damage of V_1 = -12 ECU from project A, your share of the surplus is 10 ECU and you have bid -14 ECU. Since 1 ECU equals 1 Euro, you would earn 12 Euro.

As a second example, suppose that Project B had the highest surplus and is, thus, implemented. Assume, furthermore, that the overall surplus of the project

is 6 ECU. If your bid was 13 ECU, your payoff will be 13+2-13=2 ECU. You will have to bid for all seven projects in the column "My bid".

It can be the case that the payoff for one or more participants is negative. However, this can only occur if the participant submits a bid that is higher than his personal value, that is $b_i > V_i$ (for instance, when the personal value V_i for the project is 17 and the bid bi is larger than 17 or when the personal value V_i for the project is -10 and the bid b_i is larger than -10). If you submit a bid equal to your personal value or lower, you cannot get a negative payoff. If you, nevertheless, get a negative payoff, this will be dealt with in the following way:

- first, the amount you lose will be deducted from the 5 Euro that you receive for showing-up on time
- if your negative payoff exceeds 5 Euro, there are two alternatives. The first is that you pay the difference out of your own pocket. The second is that you carry out an additional task before you leave the laboratory to make up for the remaining difference. This additional task consists of looking for a specified letter in a longer text and counting the number of times it occurs. You will get 1.00 Euro for each sentence that you process correctly. Please note that the task is for settlement of potential negative payoffs only. Under no circumstance is it possible to carry out the task to increase a positive payoff.

Final payment

At the end of the experiment, one of the 15 rounds is randomly drawn for payment.

You are going to be informed about:

1. the project which was implemented in that round (if any);
2. the surplus of the project;
3. your own bid;
4. your personal value;
5. and your payoff.

This information will only be displayed for the round that was randomly drawn. You will not be given any information on the bids of the other members of your group or on whether any project was implemented in the other rounds.

The payoff in the randomly drawn round is converted in Euro (for example, 15 ECU are 15 Euro). Your earnings will be privately paid in in cash, so that no other participant will know the size of your pay-out.

B Tables

Table 1: Prospects

Project	$C(S)$	$v_1(S)$	$v_2(S)$	$v_3(S)$	$SB(S)$
Prospect 1					
A	30.00	30.00	-30.00	45.00	15.00
B	60.00	0.00	24.00	45.00	9.00
C	36.00	6.00	18.00	18.00	6.00
AB	90.00	30.00	-6.00	105.00	39.00
AC	45.00	36.00	-12.00	75.00	54.00
BC	96.00	6.00	42.00	63.00	15.00
ABC	135.00	36.00	12.00	75.00	-12.00
Prospect 2					
A	15.00	27.00	18.00	-15.00	15.00
B	30.00	27.00	0.00	12.00	9.00
C	18.00	9.00	6.00	9.00	6.00
AB	45.00	-6.00	30.00	60.00	39.00
AC	24.00	60.00	-12.00	30.00	54.00
BC	48.00	33.00	3.00	27.00	15.00
ABC	69.00	33.00	18.00	6.00	-12.00
Prospect 3					
A	30.00	-24.00	-30.00	-6.00	-90.00
B	60.00	0.00	24.00	45.00	9.00
C	36.00	6.00	18.00	18.00	6.00
AB	90.00	-24.00	-6.00	36.00	-84.00
AC	45.00	-18.00	-12.00	12.00	-63.00
BC	96.00	18.00	60.00	72.00	54.00
ABC	135.00	-9.00	33.00	75.00	-36.00
Prospect 4					
A	30.00	15.00	15.00	15.00	15.00
B	63.00	24.00	24.00	24.00	9.00
C	48.00	18.00	18.00	18.00	6.00
AB	105.00	48.00	48.00	48.00	39.00
AC	45.00	33.00	33.00	33.00	54.00
BC	93.00	36.00	36.00	36.00	15.00
ABC	138.00	42.00	42.00	42.00	-12.00
Prospect 5					
A	30.00	78.00	-30.00	-12.00	6.00
B	60.00	0.00	24.00	45.00	9.00
C	36.00	-6.00	18.00	18.00	-6.00
AB	63.00	30.00	-18.00	105.00	54.00
AC	45.00	6.00	-24.00	105.00	42.00
BC	57.00	15.00	42.00	60.00	60.00
ABC	141.00	72.00	12.00	51.00	-6.00

Table 2: Example of subset

Subset	$C(S)$	$v_1(S) = b_1(S)$	$v_2(S) = b_2(S)$	$v_3(S) = b_3(S)$	Social Benefit $\sum_{i=1}^{3} v_i - C(S)$	Surplus $\sum_{i=1}^{3} b_i - C(S)$
AC	15	12	-4	25	18	18

Table 3: Frequency of Project Implementation

	Prospect 1		Prospect 2		Prospect 3		Prospect 4		Prospect 5	
%	Publ	Priv	Publ	Priv	Publ	Priv	Publ	Priv	Publ	Priv
None	19.9	21.9	10.0	8.2	27.0	36.3	17.5	11.7	9.2	10.7
A	1.8	2.2	4.3	3.5	0.0	0.0	1.7	0.1	2.4	2.0
B	0.6	0.3	0.5	0.3	1.6	2.1	0.0	0.0	0.1	0.0
C	0.0	0.1	1.2	0.0	2.1	0.1	0.0	0.0	0.0	0.0
AB	12.5	9.6	23.4	28.6	0.0	0.0	1.5	0.3	29.3	18.8
AC	**62.7***	**65.9**	**59.4**	**59.3**	0.0	0.0	**79.2**	**87.8**	2.7	4.9
BC	2.5	0.0	1.2	0.1	**69.3**	**61.5**	0.0	0.0	**56.3**	**63.5**
ABC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*A bold font identifies the project with the highest social benefits for the given prospect

Table 4: Determinants of relative deviations (linear mixed-effects model)

Rel.dev∼	Coef (Std. Err.)
(Intercept)	-55.379 (7.695)***
Personal.value	0.743 (0.056)***
Project.cost	-0.205 (0.033)***
Personal.values.SD	-0.210 (0.107)*
Personal.value.NEG	-15.297 (5.417)**
Soc.benefit	0.102 (0.048)*
Public.info	6.819 (9.282)
Round	-0.154 (0.239)
Pers.value×*Pers.val.NEG*	-3.932 (0.276)***
Pers.val.SD×*Public.info*	-0.300 (0.103)**
Soc.benefit×*Public.info*	-0.051 (0.055)
Prospect 2	-9.477 (3.398)**
Prospect 3	5.653 (3.578)
Prospect 4	7.156 (4.224)°
Prospect 5	-0.562 (3.303)
Num. Obs.	5757 (Subj=57)
Wald χ^2 (p-value)	< 0.001

Significance levels: *** 0.001; ** 0.01; * 0.05; ° 0.1

C Figures

Figure 1: Bids (Private Information)

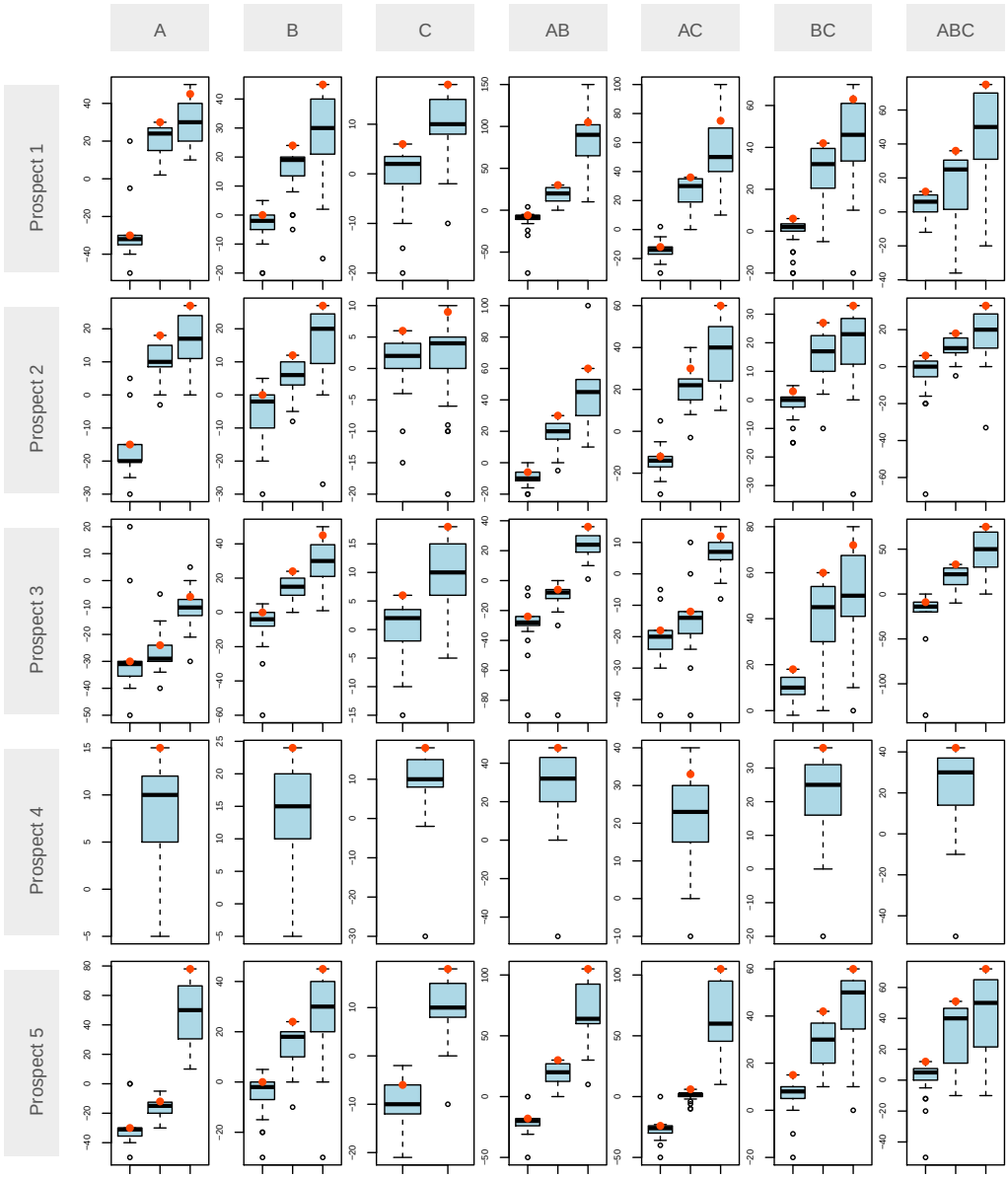

Figure 2: Bids (Public Information)

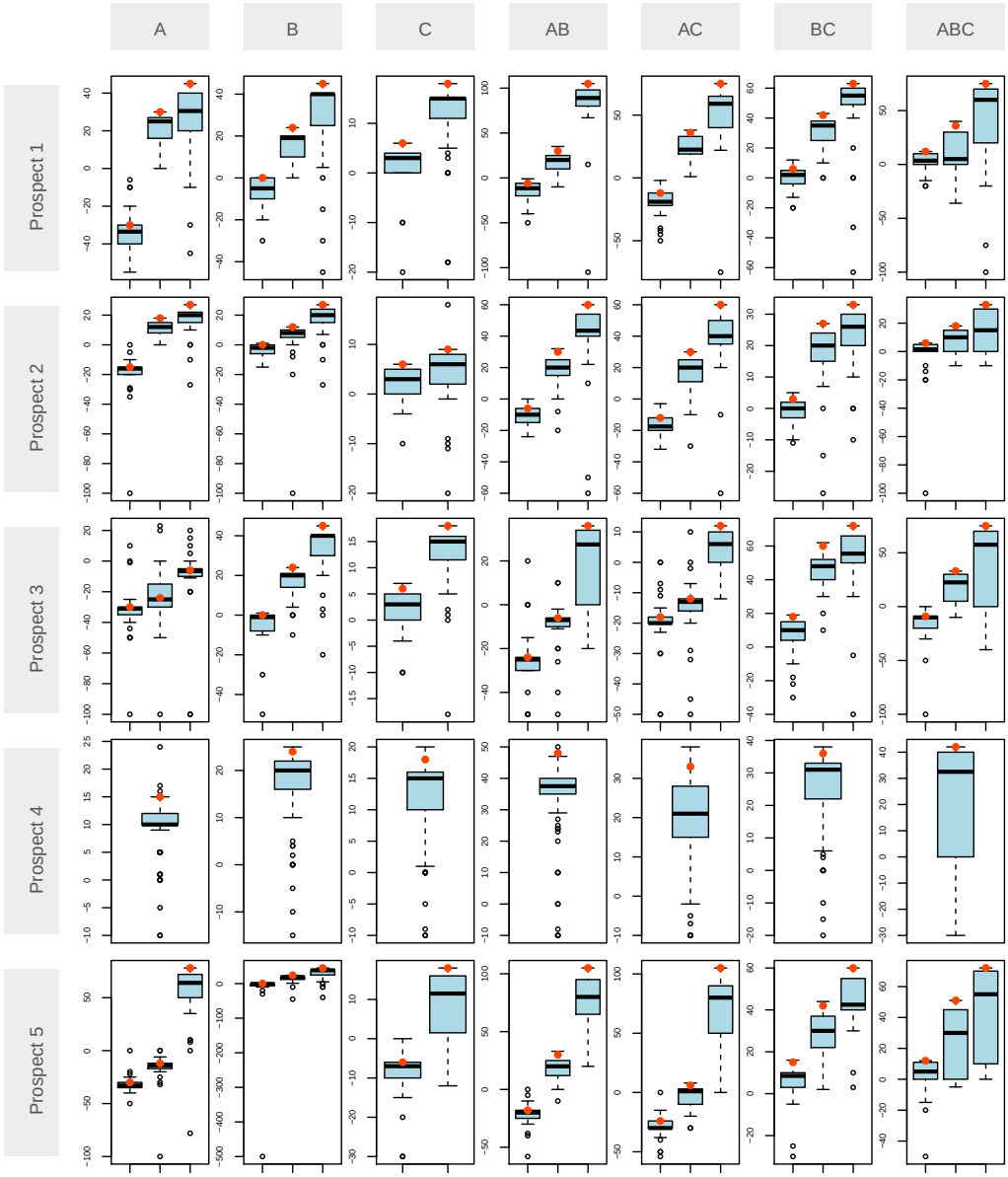

Figure 3: Relative Deviations

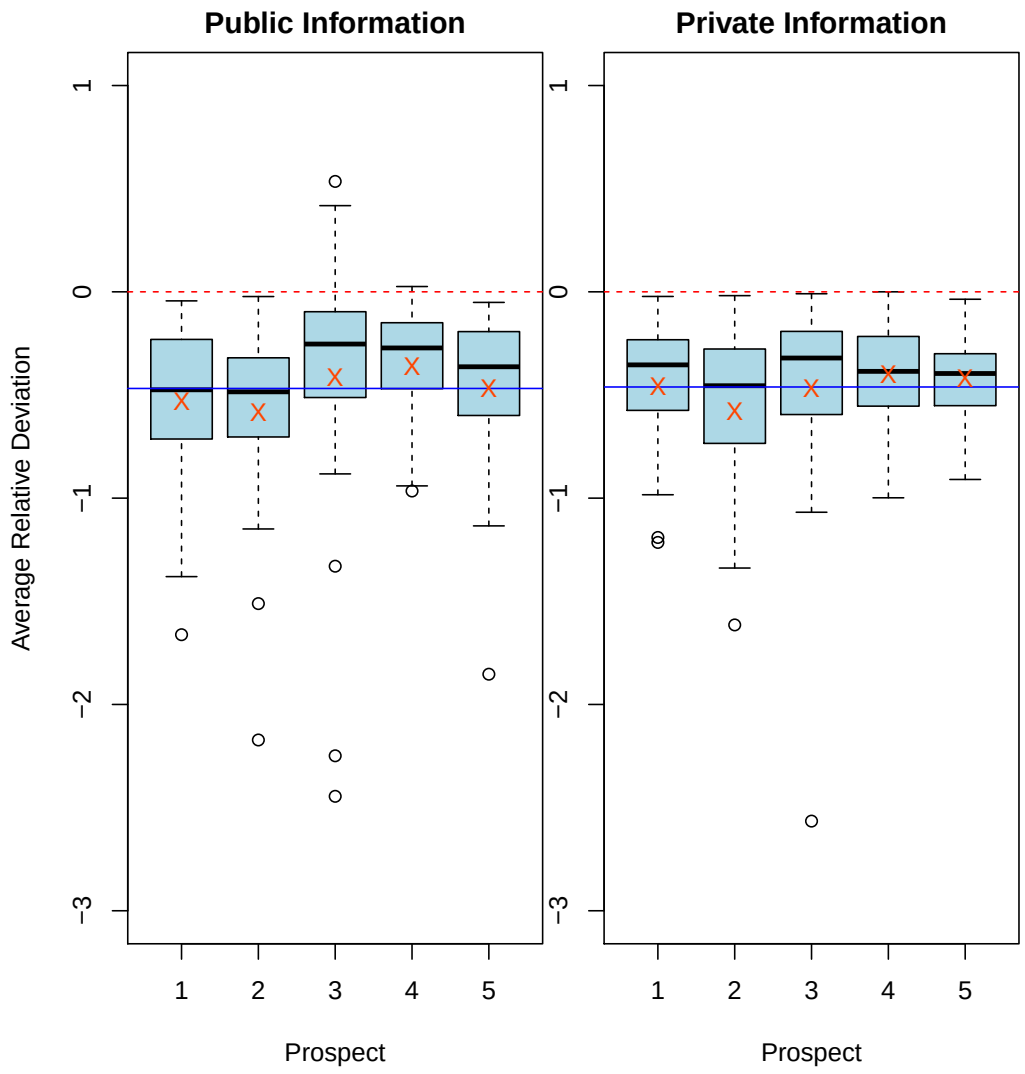

Figure 4: Surplus