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Carla Marchese

Marcello Montefiori

Voting the public expenditure: an experiment

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Voting the public expenditure: an experiment

Abstract

This paper considers the problem of voting about the quantity of a public good. An experiment has been run in order to test the extent of the strategic bias that arises in the individual vote when the social choice rule is to select the mean of the quantities voted for; conflicting theoretical predictions are available in the literature on this purpose. The political implications of the mean rule and its effects upon efficiency are also discussed.

Keywords: experiment, voting rule, public good

JEL Code: C91, D72

1 Introduction

Many mechanisms that have been suggested for collective choice do not provide incentives for sincere disclosure of preferences; misrepresentation can arise, for example under majority voting or, with reference to choices pertaining to public goods, in procedures à la Wicksell and Lindhal.

Two recent studies by Ehlers et al. (3) and by Renault and Trannoy (6) have revived the discussion on strategic behavior in social choices by focussing upon the mean vote procedure. They describe the social choice process as aimed at locating a point within a bounded space , e.g. an interval of the real line, on which the amount of a public good is measured. Under the mean vote procedure society chooses the mean of the quantities voted for by the agents. The conclusions reached by the aforementioned papers about the working of mean vote are opposite, as, under conditions that will be stated in the following, the former predicts sincere disclosure of preferences, while the latter predicts widespread strategical behavior.

In this paper, after a discussion of the theoretical problems involved in mean voting, an experiment is used to test which predictions, if any, are supported by data.

The paper is organized as follows: Section 2 presents and expounds the "opposite" statements that can be drawn from the Ehlers et al. (§ 2.1) and the Renault and Trannoy (§ 2.2) paper, while § 2.3 illustrates the historical and the present-day role of the mean vote procedure respectively in ancient and modern society. Section 3 explains the experiment setting whereas section 4 provides a preliminary data analysis. In section 5 an econometric study is implemented, while section 6 reports the conclusions.

2 The mean vote procedure

Strategical voting behavior in social choice procedures can be ruled out only under specific conditions. Moulin, in a classical paper (5), analyses the working of a mechanism in which each participant directly announces his preferred point on the real line. The median point among those voted for represents the social choice. Restriction of preferences (single peakedness) secures in this case strategy-proofness, which consists of the stability of a non-cooperative Nash equilibrium as no agent has incentive to deviate from his bliss point in response to other agents announcing their bliss points[1]. This result, however, does not carry over to cases in which preferences have an unrestricted domain or the problem is multidimensional. Other approaches aimed at securing sincere revelation of preferences and specifically designed for the revelation of public goods demand (like the Groves and Clarke mechanisms, for example, which, in the most widely known versions, imply that truth telling is a dominant strategy) have other possible drawbacks, like budget imbalance.

2.1 The mean vote and the threshold strategy-proofness

Recently the discussion about strategy-proofness in voting has been revived from a non-standard point of view in a paper by Ehlers et al. (3) who adopt a kind of bounded rationality approach to the problem of collective choice. A basic assumption made by these authors is Lipschitz continuity of the voters' utility function, a characteristic that broadly speaking means that utility does not change too fast when its arguments vary. Lipschitz continuity implies that a choice not aligned with what the agent prefers entails a utility loss not larger than L times the "distance" between the preferred point and the socially chosen one. This representation of preferences, while obviously restricting the permissible transformations of the utility function, is in line with the idea of a kind of limited ability of agents in perceiving the utility effects of decisions pertaining to public goods. This might be justified by the complexity which characterizes the collective action and the provision of public goods. Agents might simplify things by considering, for example, that no more than a given utility amount can ever be gained through a unit increase in the amount of a public good.

The mechanism studied by Ehlers et al. (3) refers to a multidimensional decision problem: i.e. society must choose a point within a finite subset of a Euclidean space, whose dimensions refer to the issues at stake (i.e. in each dimension the amount of a given public good or the availability of a given political attribute in a decision is measured). The suggested procedure is the mean vote, i.e. society chooses the point whose coordinates are the mean of the coordinates of the points voted for by citizens. Every participant thus votes for a point, by supplying the vector describing his preferred choices in each dimension.

With reference to a large enough polity, the mean will become rather in-

[1] Strategy-proofness holds for coalitions as well.

sensitive to the individual vote, thus implying only a small benefit of lying in preference reporting. By considering that Lipschitz continuity also sets a cap on the effects in utility terms, mean voting turns out to be "sharply threshold strategy proof", as the gain from lying cannot exceed a given threshold. By considering that finding an advantageous strategy for misrepresentation of preferences is likely to be demanding in terms of information and calculus, threshold strategy-proofness implies a prediction of truth telling in mean voting procedures whenever the costs of strategical behavior exceed the threshold. The level of the threshold in turn depends positively on the Lipschitz constant L (i.e. the parameter describing the maximum reactivity of the utility function), which is assumed to be the same for all the voters, and negatively upon the number of participants in the decision process.

A problem arising from the Ehlers et al. (3) approach is that they consider a multidimensional decision in which only public goods or dimensions of a social choice are involved, i.e. in their model all individual utility functions are defined on the same domain. Hence, to apply their approach to a problem pertaining to public goods, it must be assumed that tax shares have already been set, in order to eliminate the private good from the utility function. This also means, as routinely happens in median voter models, that a change in the rule for sharing costs modifies the induced individual preferences and the result of voting. Even with these limitations the approach of Ehlers et al. (3) seems to offer quite a significant way out with respect to the problem of strategical behavior in collective choices.

2.2 Strategic behavior in mean voting

A somewhat more pessimistic message is conveyed by another recent paper that deals also with the mean voting mechanism and considers the voters' optimal strategies in this case. The differences in the conclusions with respect to the paper by Ehlers et al. (3) that will be discussed subsequently are largely due to the fact that Renault and Trannoy (6) consider standard fully rational economic agents. In their setting voters have single peaked preferences defined on a segment of the real line (on which, for example, the quantity of a public good is measured), i.e. their problem is unidimensional. Like in the Moulin (5) paper, voters announce (either sincerely or not) their preferred quantities. Society, however, does not select the median but the mean, where the mean can be simple (i.e. one man one vote) or weighted. Building upon results available in the literature, the authors are able to show that there is a unique Nash equilibrium allocation for this game. The allocation represents a cut point that separates players into two groups, i.e. all the members of one group would like an amount larger than the equilibrium one and thus vote for the maximum quantity of the public good (with reference to the interval in which the social choice must lie) whereas the members of the other group would like a quantity lower than the equilibrium amount and thus vote for the minimum quantity. The working of the model is illustrated in Figure 1. Let us assume perfect information of voters about all the bliss points and the corresponding voters' weights. Consider a

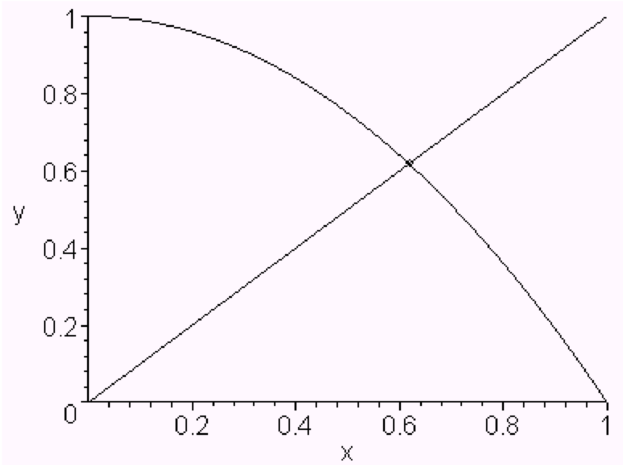

Figure 1: Nash equilibrium of mean vote

continuum of voters indexed by x, uniformly distributed[2] on the unit interval $[0, 1]$. Consumers with a high x have a low bliss point y, i.e. a low preferred quantity of the public good. In Figure 1, therefore, the negatively sloped curve represents bliss points as a function of x, while the positively sloped curve represents the cumulative weight in terms of votes. As an equal weight for all the voters has been assumed in the Figure, the latter curve is the 45° line. Note that the cumulative weight curve also measures the value progressively assumed by the mean if voters vote 1. The cut point is the abscissa of the point where the two curves intersect, while the equilibrium allocation is the ordinate of the same point. On the left-hand side with respect to the equilibrium point, as long as the bliss points curve lies above that of cumulative weights, by voting 1 the agent reduces as much as possible the gap between the social choice so far (i.e. the cumulative weight) and his bliss point. The opposite reasoning holds on the other side, where the curve of cumulative weights lies above the bliss points curve. Voters on this side vote 0. For the agent located at the cut point, the bliss point and the progressive mean coincide. On the other hand, because of the continuity assumption, this type is of measure zero. Thus the model predicts that virtually all the agents will hide their preferences and choose an extremist behavior. When there is a discrete number of agents, on the other hand, it might happen that one agent[3] exactly reaches his preferred quantity by fine tuning his vote within the interval, thus adopting a non-extremist behavior. Renault and Trannoy (7) also find that the strategic bias is independent of the information structure of the game, and thus occurs also when the assumptions

[2] We resort to some simplifying assumptions only for expository purposes. For a more general presentation see Renault and Trannoy (6).

[3] If there are many voters in this position there might be multiple Nash equilibria, while, however, the equilibrium allocation is still unique.

pertaining to the participant's information about the other people's bliss points or weights in the vote are relaxed.

As far as the equilibrium allocation is concerned, it may or may not coincide with the mean of actual bliss points. Mean vote performs better than the median one in eliciting the actual mean of bliss points if the latter (once data have been normalized) is central in the interval $[0, 1]$.

2.3 The political relevance of the mean vote rule

To the best of our knowledge, there is no political tradition concerning the use of a mean rule in voting. Procedures that work more or less as if a mean rule were adopted can be found, however. Some interesting cases are reviewed by Renault and Trannoy (6). They focus particularly upon the "forced to pay free to choose" mechanisms, under which agents choose which share of the taxes they pay must go to specific uses, e.g. to the financing of their preferred school district or to a specific religious confession. The amount of money devoted by society to each of these uses can thus be seen as the mean of the shares chosen by taxpayers, weighted by the amount of taxes that each citizen pays. In fact the currently used mechanisms only allow discrete choices (e.g. in Italy taxpayers have to decide whether to allocate 0.8% of income tax to a religious confession or not), but if the prediction of extremist behavior holds, the only relevant alternatives are in fact discrete and extreme, and thus the idea of mean voting is tenable.

One might also rationalize in terms of mean vote the procedures based on rotation, under which the choice is made by a member of the relevant body that stays in charge for a given (short) period and then steps down while a second member takes charge. The policy that ensues over a period (e.g. one year) can then be described as the mean of the policy choices made by the members, where individual choices are weighted by the time span in which everyone is in charge and by the appropriate discount factor if relevant. Rotation has been widely used in the European institutions and is also provided for in the Lisbon Treaty.

Another approach that can be rationalized in terms of the mean rule is the random assignment of the right of deciding to a member of a social body who stays in charge for a short period and is followed by another member chosen at random too, and so on. The method of drawing lots was widely used in classical Athens to select chairmen of political assemblies, members of the government, officials and judges; in fact drawing lots was the rule while other methods of selection were the exception. Drawing was often used jointly with rotation. Arisoteles[4] for example refers that the epistate of the Pritaneon who, among other powers and duties, was in charge of guarding the Treasury of the State, was drawn to serve for one day and could hold that position only once in life.

The logic behind these approaches seems that of protecting against dictatorship and corruption, avoiding a too fierce political struggle for power and

[4] in the Athenaion Politeia, 44, 1.

securing low transaction costs. When equal weights are adopted, participants in the decision process are endowed with equal power and are assumed to have equal ability to represent the whole body. Mean voting differs from the rotation and random selection procedures mainly because it avoids variance around the mean (and hence the risk) that the latter systems involve. Renault and Trannoy (6) also stress a potential role of the mean rule for protecting minorities. In the "forced to pay free to choose" model, for example, religious minorities can convey funds to their preferred schools, while a median voting procedure might disregard in full their preferences (i.e. the median voter might choose a zero amount for a good that is of vital interest for a minority). Thus mean voting might prevent social unrest or secessions in multiethnic or multireligious countries or federal states.

Unfortunately, the mean rule does not secure efficiency in the choice of the collective good amount, even in cases in which sincere revelation of preferences occurs. While Bowen (2), in a famous contribution, has shown that efficiency occurs when the mean of marginal rates of substitution equals marginal cost/number of agents (which is the equivalent of the Samuelson efficiency rule, i.e. the sum of marginal rates of substitution equals marginal cost), this is a condition referred to mean demand prices and not to mean quantities. From this point of view, the mean rule does not seem better than the median rule implied by majority voting, i.e., neither secure efficiency in collective choices.

3 The experiment

The aim of the experiment is to test whether the mean rule actually prompts sincere revelation of preferences or not, and in the latter case if extremist behavior prevails. It also aims to test the effects of the mean voting rule upon social welfare.

Three sessions[5] were run in from March to June 2007 at the AL.EX laboratory of the University of Eastern Piedmont "A. Avogadro" in Alessandria (Italy) and at the laboratory of the University of Milano - Bicocca in Milan (Italy). The participants were in total eighty undergraduate students from different years and faculties. Each session took about an hour and the payment was around 15 euros per capita.

In order to keep the experiment simple, it was designed in just one dimension, by inviting the participants to vote for their preferred amount of a public good[6] in the interval $[0 - 150]$. In the experiment, participants receive payoffs based on a utility function, with a single bliss point comprised in the interval $[15 - 135]$. Utility (i.e., payoff) decreases linearly on both sides of the peak (set at 15 for all the participants) with a slope of $1/10$. The range limitation $[15 - 135]$ set for

[5] The experiment was programmed by Marie-Edith Bissey and conducted with the software z-Tree (Fischbacher 1999(4)).

[6] The presentation in the instructions was in a neutral language, and refferred to the decision about an expenditure that conveys net benefits to the group and which gives rise to individual payoffs that will be specified in a schedule.

the bliss points is required in order to leave each player "enough distance" from the extremes allowing him for a strategic space/behavior in both directions. New utility schedules are randomly selected at each round and assigned to each participant.

The utility function is assumed to describe each participant's net benefit[7] as a function of the amount of the public good. In the restricted interval $[0, 150]$, the utility functions considered are Lipschitz continuous, with constant $L = 1/10$. However, it is obviously by no means taken for granted that when the payoff is evaluated by each participant on the basis of his actual individual utility function this characteristic still holds.

The actual payment to each participant is represented by his payoff in a randomly selected round out of the 15 actually played, plus 5 euros as a show-up fee.

Participants to the experiment are assigned, in turn, to groups of 2, 4 and 8 people. During the experiment agents are reassigned randomly to groups at each round. Agents are always informed about the procedure used for making the collective choice (the mean) and they have full information with reference to: i) number of the members of their group; ii) payoffs schedule of the other members of their group; iii) the previous rounds' results, in terms both of social choice and personal payoff. The actual choices and payoffs of the other players are not displayed. All the afore-mentioned information were visible on the screen.

The experiment procedure and agents' group assignment is described in Table 1.

Groups are formed on random basis and without repetition with reference to individual payoff (i.e. each agent always meets people having different bliss points). Half of the participants start with group size equal to 2, while the remaining participants with a group size equal to 8. After five rounds the group size is set equal to 4 for all the participants. In the final five rounds the group size becomes equal to 8 for those participants who started with group of 2, while it becomes equal to 2 for the remaining participants. The increasing and the decreasing group size are intended to test if, and in case in which way, the different setting may affect the players' behavior. To note that both the information and the procedure implemented for making the collective choice (mean) do not vary during the entire experiment.

[7] It is thus assumed that the cost shares have been set, so that each agent's utility only depends on the public good.

Round			Total number of observations
1,..,5	40 people in groups of 2	40 people in groups of 8	400
6,..,10	80 people in groups of 4		400
11,..,15	40 people in groups of 8	40 people in groups of 2	400

Table 1: the experiment design

4 Data Analysis

In Table 2 agents are classified[8] according to whether they cast a vote "biased" toward the strategy put forth in the Renault and Trannoy paper or they reveal their bliss point. A strategical bias occurs, for instance, when an agent with a bliss point of 60, who should vote 0 according to the strategy, reports 20 instead. In this case the participant is classified as strategical since she lies in the "right" direction (understating her bliss). Such a behavior might arise, e.g., if a player assumes that only a share of the participants is strategical while the remaining are sincere. Since in this case the expected behavior of the other participants is less extreme, it might pay to respond by reducing one's own extremism.

Table 2 also reports the percentage of those who revealed their preference. It is assumed that revelation occurs if the actual vote is close to the real bliss, i.e. $\pm$ 7.5 around this latter along the $0 - 150$ voting line, as a small deviation might represent a sketchiness error.

Strategical behavior (as previously defined) and sincere revelation are able to describe the conduct of around 70% of the participants. The share of those who reveal their preferences is considerable[9] (around 20%). On the other hand, full disclosure is rare (6%), and strategical behavior (in a more mild or strict form) is prevailing (about 50%). In case of a random choice one expects that revelation or quasi strategical behavior would occur[10] with a probability of 10%, sincerity or pure strategy with a probability of 0.07%, and a strategical bias [11]

[8] All the percentages in Table **2** refer to the total by raw. In particular:
strat. bias refers to choices that deviate from the bliss in the direction of the strategical choice acording to Renault and Trannoy. It excludes, however, quasi-sincere revelation (± 7.5 with respect to the bliss), even when in the correct direction;
quasi-extremist refers to choices ± 7.5 with respect to the Renault and Trannoy strategy. This is a subset of *strat. bias*;
extremist refers to exact strategy.implementation; this too is a subset of *quasi-extremist;*
quasi-sincere refers to choices ± 7.5 with respect to sincere revelation;
sincere refers to full revelation of the bliss and is a subset of *quasi-sincere.*

[9] In a previous experiment, in which a similar game was played in groups of 3 [see Marchese and Montefiori (Marchese)] the revelation turned out to be larger. In that case, however, the participant kept the same utility function during the whole experiment, a fact that might have contributed to reinforce the perception of the bliss as a reference point.

[10] Since they occur if the vote lies in an interval of ± 7.5 with respect to the exact value, while the whole available interval is $[0, 150]$.

[11] Since the strategy under consideration mainly suggests of reaching the nearest extreme

INCREASING group size	|Strategy			|Revelation	
Group Size	strat. bias	quasi-extrem.	extremist	quasi-sincere	sincere
2 - people	**36.50**%	14.50%	11.50%	**31.50**%	7.00%
4 - people	**42.00**%	26.00%	22.00%	**23.00**%	3.00%
8 - people	**48.00**%	33.00%	26.00%	**21.50**%	5.50%
DECREASING group size	|Strategy			|Revelation	
Group Size	strat. bias	quasi-extrem.	extremist	quasi-sincere	sincere
8 - people	**58.50**%	33.50%	30.00%	**17.00**%	8.00%
4 - people	**58.00**%	42.50%	36.50%	**18.00**%	6.00%
2 - people	**53.00**%	41.00%	34.00%	**23.50**%	8.00%
SUMMING UP	|Strategy			|Revelation	
Group Size	strat. bias	quasi-extrem.	extremist	quasi-sincere	sincere
2 - people	**47.50**%	24.00%	20.75%	**28.75**%	7.50%
4 - people	**50.00**%	34.25%	29.25%	**21.75**%	4.50%
8 - people	**50.50**%	37.00%	30.00%	**21.25**%	5.75%
ALL	**49.33**%	31.75%	26.67%	**23.92**%	5.92%

Table 2: Modes of behavior under different group size

with a probability of 23.62%. A binomial test[12] applied to each of the mentioned modalities is significative at 1% level and thus the hypothesis of a purely random behavior of the participants can be rejected.

The data do not support the expectation, based on the Ehlers et al. paper, of an increase in the percentage of sincere revelation with the increase of group size. The chi-square tests conducted on pairwaise comparisons are in general not significative, while it turns out that in the first round there is less strategical behavior (both with reference to the ± 7.5 interval around the strategical value and with reference to the strategical bias) in the smallest groups (with 2 people) rather than in the largest ones[13] (with 8 people), i.e., the opposite result with respect to the expectated one, since in a small group it should be easier to figure out the optimal strategy. On the other hand, the chi square test reveals that when playing in groups of 4, the participants who previously played in groups of 8 are more quasi-strategical than those who played in groups of 2.

There is some evidence that more experienced subjects are less keen to reveal their preference and point to a more strategical behavior. Table 3 shows that the percentage of sincere and extremist behavior varies from the first to the fifth round given the same group size. With reference to groups of 2 people the chi square test confirms that the decline in sincere revelation is significative at 5% level, This may indicate a learning process in the smallest groups.

	Without experience (1st round)		With experience (5th round)	
	Group size 2	Group size 8	Group size 2	Group size 8
Sincere	11.25%	6.25%	3.75%	2.5%
Extremist	21.25%	30%	25%	36.25%

Table 3: modes of behavior (in percentage) at first and fifth round for group size of two and eight

The discovery of the equilibrium strategy might in general be easier for side players (i.e., for those whose bliss points are more far with respect to the median) than for central players. It has been assumed that in the groups of 8 people there are 4 side players, while in the group of 4 there are 2 side players. Table 4 compares the observed percentage of participants that bias the vote in the correct direction with respect to the percentage that would be expected on a purely random basis. Side players have usually a lower expected strategical bias, since they have less "room for manoeuvre". Nevertheless the chi square test confirms that with reference to both group size, side players show a strategical bias more often than central ones.

With reference to groups of 2 people, it is not clear if players should be classified as side or central. The lack of a clearly identifiable relative position

of the available interval, the observed average distance of the strategical choice from the boundary of the quasi-sincerity is 35.42.

[12] Or a z test with a correction for normal distribution when needed (see Siegel and Castellan,p. 43).

[13] The chi-square test is significative both at 5% and 1% level.

	Group size 8		Group size 4	
	side	central	side	central
actual	55.67%	36.00%	55.50%	45, 00%
expected	23.81%	48.81%	38.70%	77.75%

Table 4: modes of behavior (in percentage) at first and fifth round for group size of two and eight

might explain why, contrary to the expectations, strategical behavior is not larger in the groups of 2. In larger groups people might also have considered forms of implicit cooperation with those on the same side. Another explanation for the results pertaining to the smallest groups might hinge upon some kind of visibility concern: if someone cheated this was immediately visible[14] for the other party in a group of 2, while in larger groups the individual behavior of each of the other partners was quite difficult to assess.

In figure 2 it is shown that the distribution of the bliss points was about uniform in the interval $(15, 135)$, as expected since the bliss were randomly chosen in this interval. Figure 2 also shows the distribution of strategical choices according to the Renault and Trannoy strategy. This exhibits the classical bimodal pattern due to the prevalence of extremist choices. The pattern of the actual choices over the whole experiment is trimodal, confirming that actual behavior tends to reproduce (and thus reveal) the actual distribution of bliss points mainly in the middle of the interval, while the high frequences of extremistic votes confirms that there is some strategical bias in the observed behavior.

The frequency distribution of actual choices in the groups of 2 (Figure 3) shows, however, a less pronounced bias of actual choices toward the extremes.

An issue which deserves attention concerns the social welfare loss/gain which emerges from the different scenarios. To cope with this point we have computed the hypotetical sum of payoffs according to Ehlers et al. or to the Renault and Trannoy predictions. The actual total amount of payoffs, by group size, are computed and reported in the table below. The result that actually occurred in the experiment is intermediate between that predicted by Ehlers et al. and that predicted by Renault and Trannoy.

Sum of payoffs	Group Size			
	-2-	-4-	-8-	Tot
Actual choice	4993.45	4823.94	4847.51	14664.90
Ehlers et al.	5190.80	4933.70	4899.70	15024.20
Renault et al.	4768.60	4773.60	4825.55	14367.75

Table 5: sum of actual and predicted payoffs

As far as the individual behavior is concerned, the participants did not follow

[14] Since the outcome was displayed, it was easy to figure out the vote of the partner.

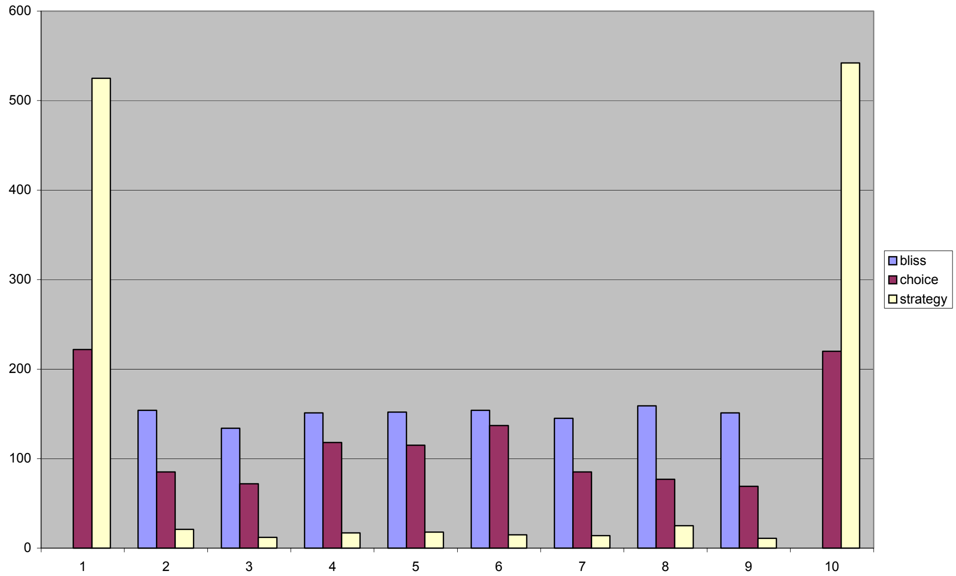

Figure 2: Frequency distribution of blis points, actual choices and stragical choices

any simple fixed rule of conduct during the experiment. However, strategical behavior seems a more stable mode than revelation, since 48 participants out of 80 biased their vote in the correct strategical direction in more than 50% of their choices[15], while only 11 showed the same persistence in nearly revealing their bliss (± 7.5). Since no one was always fully sincere, one may argue that revelation did not occurr as a clear-cut persistent behavioral choice, but was probably prompted by other factors, such as that the bliss represented a natural reference point. The strategical attitude (even in absence of an actual ability at implementing an effective strategy) is confirmed by the questionaires the participant filled in at the end of the experiment. Around 80% said that telling the truth was not the best choice, and that by lying in such a game one might improve his own payoff. The main motivation chosen by those who stated that telling the truth was the best choice was that it was so in absence of information about better possibilities. About 80% of the participants reported in the questionnaire of having often chosen points near their actual bliss, but the main motivation was in this case that their bliss was intermediate with respect to the other participants.

In order to assess the results of the experiment, it might be useful to com-

[15] 25 are quasi-strategical (± 7.5 with respect to the Renault and Trannoy predictions) in more than 50% of their choices, while 36 show a strategical bias in more than 70% of their choices.

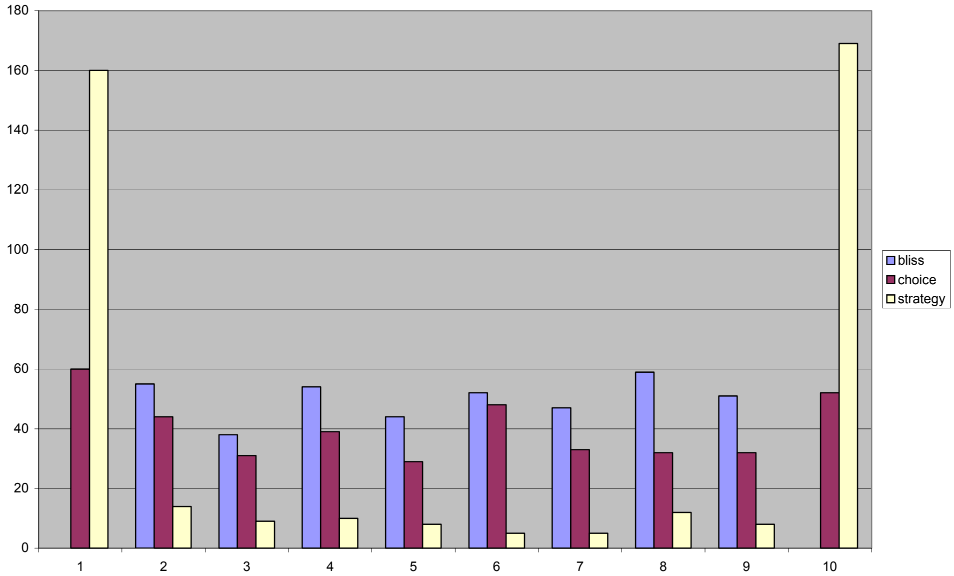

Figure 3: Frequency distribution of bliss points, actual choices and strategy (groups of 2)

pare it with the "beauty contest" game, which has some similar features[16]. In a "beauty contest" players simultaneously choose a number in an interval, and the winner is the person who choses the number closest to p-times the mean of the "votes", with $p < 1$. This game has a unique Nash equlibrium, in which everyone chooses the smallest number of the interval. Thus in the beauty contest too one expects the participants to become "extremist". There are a lot of experimental results pertaining to the beauty contest, either from laboratory experiments or from games launched by newspapers among their readers. In many cases (particularly in the laboratory) the convergence toward the Nash equilibrium in the beauty contest is slow or nil, and the numerosity of the group seems ininfluential. Better results are reached by allowing communication and disclosure of the actual choices of the participants in previous rounds. The game in the experiment presented in this paper is somewhat more difficult, because every participant must discover his own strategy, which, even in groups of 2, is not dominant. On the other hand, in the game played in this experiment, the participants are informed about the other people's bliss points and payoff functions. This provides a valuable information, not available in the beauty contest. Our results, at any rate, show that the Nash equilibrium was not reached, while, however, there was some strategical bias in the observed behavior.

A deeply studied topic with respect to the beauty contest is the type of assumption that each participant makes about the other's participants' behavior. From the individual choices, one can infer the assumptions about the other people's behavior that rationalize it. In this experiment a mild bias toward the extremes might be explained by assuming a mix of strategies adopted by the other players (some telling the truth and some lying). In the questionnaire more than 50% of the participants report that in their opinion the other participants either told the truth or cast a vote not far from their bliss. Hence, as in many beauty contest games, the participants showed a low degree of sophistication, i.e., of ability at figuring out the best reply that each party could have given to the other one. Through econometric tecniques, in the following section we aim at assessing the role of factors - besides the quest for a best reply -that might have contributed to shaping the observed choices, such as forms of reaction and adaptation to the observed outcome for the group, or learning processes eased by the specific locations of the bliss, etc.

5 Econometric analysis

In order to further understand the determinants of player's behaviour we have conducted an econometric analysis. The data consist of a panel of 80 individuals over 15 round period. Therefore the sample consists of 1200 observations with 15 observations per person.

The first estimated parameters are listed in table 6. The regression's dependent variable "strategy" measures the player's strategic behaviour; it represents the absolute value of the difference between the player's actual choice and his

[16] For a review, see Bosch-Domènech et. al. (1) and the references quoted therein.

bliss. The larger becomes that distance, the more the player, by deviating from his bliss, behaves strategically.

The table shows that five coefficients are highly significant and have the expected sign.

The variable *groupsize* refers to the number of players member of the group. Strategic behaviour positively depends on group size. As already pointed out, this result runs against the theoretical expectation, based on the fact that it should be easier to find out an effective strategy the smaller is the group.

delta_ bliss_ mean represents the distance in absolute value of the individual preferred amount of public good with respect to the group specific mean value, i.e. the public good amount which would be chosen by the group if all the members would have truly revealed their preferences. This variable is intended to measure the opportunity for lying available to the player, in terms of distance of his bliss point from the group mean. The positive sign associated with the *delta_ bliss_ mean* coefficient gives some support to the interpretation that this opportunity was mainly exploited by voters who were far from the group mean. Such an inference accords also with the results discussed in § 4 with reference to the relevance of the agent's location as a factor that influences the propensity to behave strategically. On the other hand it seems to clash with the result provided by the *location* variable in the econometric regression. This latter is a dummy which is set equal to 1 when the player's location is close to the ends of the voting interval, 0 otherwise. The interpretation of the sign of it suggests that approaching the ends, players reduce their strategy. Actually if people have bliss falling below 30 or above 120 (that is by definition "extremist" voters), then their "room for manoeuvre" is consistenly reduced. However the *location* variable does not result to be significant in affecting the individual strategy in the first regression but it does, with a confidence interval of 90%, in the second.

average_ bliss_ mean represents the group average distance of individual bliss from group mean. A high value of this variable implies incentive to cheat, i.e., a likely strategic behaviour of others in order to contain the loss. On the other hand a very low value associated to this variable might even imply the player's incentive to be sincere given the low risk incorporated in the decision.

delta_ RT_ bliss is a variable intended to catch the predictive accuracy of the Renault and Trannoy expectations. The value of this variable represents the distance, in absolute terms, between the Renault and Trannoy voting prediction and the individual's true preferences (bliss). The high significance and the sign of the parameter associated to this variable allows us to state that the Renault and Trannoy predictions are able to explain (to some extent) the player's strategic behaviour and his "strategy trend", what has been defined as strategical bias in table 2.

E*xperience* is a trend variable intended to capture the players' experience. It varies from 1 (first round of each treatment) to 5 (last round of the treatment).

Table 6 reports the results of a PCSE estimate which allows consideration of heteroskedasticity with AR(1) autocorrelation[17].

Dependent variable: **strategy**	Coef.	$P > \|z\|$
experience	.7067128**	0.059
groupsize	.5714486*	0.028
delta_bliss_mean	.2905232*	0.000
average_bliss_mean	.0936078	0.126
location	-2.846635**	0.082
delta_RT_bliss	.2023883*	0.000
constant	7.111222*	0.019

Prais-Winsten regression, heteroskedastic panels corrected standard errors
Time periods: 15 No. of groups: 80
Panels: heteroskedastic (balanced); Autocorrelation: panel-specific AR(1)
No. of obs.=1200 R-squared=0.2927
Wald chi2(6)=115.53 Prob>chi2=0.0000
*= Significant at 5% level of significance
**= Significant at 10% level of significance

Table 6: FGLS estimate

By the second estimated parameters reported in table **??** we attempt to explain the probability of observing a sincere disclosure of preferences. To this extent we implement a probit random effects, a logit random effects and a logit fixed effects regression with the binary outcome represented by the true revelation of preferences by voters. The dependent variable assumes value 1 when people *quasi-sincerely* reveal their preferences and 0 otherwise. As already seen in the previous section related to the non-parametric analysis, quasi-sincerity occurs when player's vote is included in a bounded interval (± 7.5) around his bliss.

The explanatory variables used in this new setting are those already used in the previous pcse regressions, plus the *ruleofthumb*. The latter is a variable obtained by the difference between the individual bliss with respect to the actual amount of the public good chosen inside each group (on the basis of the actual individuals' votes) at time t-1. The goal of this variable is to capture a behavior based on *ex post* systematic adjustment to the previous round result which conveys information about the other players' vote. This might represent a relevant factor with respect to sincere revelation, since as already seen, it occured mainly as an intermittent conduct. While the sign of the variable turns out to be the expected one, it is not, however, statistically significative.

The parameters associated to the explanatory variables have to be interpreted in terms of probability that they are able to affect the "honest" individual behaviour. It is interesting to note the asymmetry of the results if compared with those of table 6: the signs of coefficients are, in this case, reversed (with

[17] The model has been chosen in order to take into account the panel data characteristics and the problems highlighted by inferential tests.

respect to the pcse model) because they have to explain not the strategic but the sincere behaviour.

	Random-effects probit regression		Random-effects logistic regression		Conditional fixed-effects logistic regression	
Binary outcome: **quasi-sincerity**						
	Coef.	$P > \|z\|$	Coef.	$P > \|z\|$	Coef.	$P > \|z\|$
experience	-.0167174	0.661	-.0317134	0.636	-.0194088	0.772
groupsize	-.0027554	0.902	.0031915	0.937	.0121879	0.768
ruleofthumb	-.0048087**	0.063	-.0087395**	0.061	-.009749*	0.043
delta_bliss_mean	-.0397646*	0.000	-.0700351*	0.000	-.0693432*	0.000
average_bliss_mean	-.0049555	0.460	-.0115579	0.338	-.0149875	0.220
location	.3907396*	0.026	.6515537*	0.037	.6137358**	0.053
delta_RT_bliss	-.003191	0.416	-.0058538	0.386	-.0065955	0.335
constant	.2385223	0.441	.5067782	0.350	-	-
Number of obs =	1120		1120		896	
Number of groups =	80		80		64	
Wald chi2(8) =	106.36		98.60		LR chi2(7)=132.66	
Prob > chi2 =	0.0000		0.0000		0.0000	

*= Significant at 5% level of significance; **= Significant at 10% level of significance

Table 7: Probit and Logit regressions

To note that in the case of the logit regression with fixed effects the number of observations is 896 instead of 1120 due to the fact that 224 observations have been dropped (it occurs when the outcomes are all positive or all negative). In this latter we observe for the groupsize parameter a positive sign. This result might seem to clash with that of the previous regression but two aspects have to be taken into account: the first is that it is not statistically significant and the second is that it could be determined, at least with reference to the fixed effects model, by the different sample size of the fixed effects model.

6 Conclusions

The experiment was designed in order to test if the mean voting system is in practice strategy-proof or if instead it pushes the voters toward a strategical and mainly extremistic representation of their preferences. The former prediction from the theoretical point of view was stronger for large than for small groups.

The results show that an about sincere revelation occurred for a small but significant proportion of votes, and that it in fact it is likely to have arisen because the participants found it difficult to figure out an effective strategy. This gives some support to the idea, put forth in the Ehlers et al. paper, of threshold strategy-profness. On the other hand, the role of the size of the group either turned out as not significative (in explaining the share of those who nearly-revealed their bliss) or run in the opposite direction with respect to what was expected (in explaining the extent of the deviation of each vote from the bliss).

While in the experiment no group was able to reach the Nash equilibrium, a large share of the votes (around 50%) was biased in the direction predicted by Reanult and Trannoy. These predictions turn out also to be significative in the regressions aimed at explaining the participants' behavior. Moreover, the strategical bias seems also a mode of behavior that more persistently characterizes some players, while sincerity was a more intermittent way of playing.

Many results of this experiments echo those reached in the "beauty contest" games. While the participants aim at behaving strategically, they are generally not much able at figuring out other palyers reactions at further levels. However, there are some specific features of the game played in this experiment, referring, e.g., to the importance of the relative location of the players (central or side) and to each player's position on the voting line. The behavior seems thus also influenced by the actual opportunities of manouvre and by the implicit recognition of possible forms of tacit cooperation between side players.

With reference to the working of mean voting systems, one may infer that in real life a social choice systems based, e.g., on the "forced to pay free to choose" mechanism is likely to produce results not far from those that would be prompted by a sincere revelation of preferences, since many people would find it difficult to build rational strategies, while a bias toward extremism is likely to involve mainly those who are already in a side position.

On the other hand it emerges that strategical conducts tend to increase when conditions become more favorable, thanks for example to repeated participation in the experiment. Hence it also seems reasonable to expect strategical behavior to arise in committees consisting of experienced professionals and extremist strategies to represent a relevant limit result for these cases.

References

[1] Bosch-Domènech et al. (2004). "Finite Mixture Analysis of Beauty-Contest Data from Multiple Samples", *mimeo.*

[2] Bowen, H. R. (1943). "The Interpretation of Voting in the Allocation of Economic Resources." *Quarterly Journal of Economics 58*, 27-48.

[3] Ehlers, L., Peters H. and T. Storcken (2004). "Threshold Strategy Proofness: on Manipulability in Large Voting Problems." *Games and Economic Behavior 49*, 103-116.

[4] Fischbacher, Urs. (1999)."z-Tree - Zurich Toolbox for Readymade Economic Experiments - Experimenter's Manual." Working Paper Nr. 21, Institute for Empirical Research in Economics, University of Zurich.

Marchese, C. and Montefiori, M. (2008). "Meccanismi di voto e scelte collettive: un'analisi sperimentale." Studi Economici, forthcoming.

[5] Moulin, H.(1980) "On Strategy-Proofness and Single Peakedness." *Public Choice 35*, 437-55.

[6] Renault, R. and Trannoy, A. (2005). "Protecting Minorities through the Average Voting Rule." Journal of Public Economic Theory, Volume 7, pp. 169-199

[7] Renault, R. and Trannoy, A. (2004). "Assessing the Extent of Strategic Manipulation for the Average Voting Rule." *mimeo.*

[8] Siegel, S. and Castellan, J. Jr. (1988). "Nonparametric Statistics for the Behavioral Sciences", 2° Edition 2002, McGraw-Hill, New York.

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UNIVERSITY OF SIENA
PIAZZA S. FRANCESCO, 7 53100 SIENA (ITALY)
http://www.labsi.org labsi@unisi.it