Testing Storable Votes in Large Elections. The Columbia Student Councils Elections[*]

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Abstract

Theory suggests that people voting simultaneously over multiple binary proposals would benefit from being granted, in addition to their regular votes, a bonus vote. The bonus vote allows them to single out the issue they consider their highest priority and increases ex ante expected utility. In the Spring of 2006, we attached a short survey to students' election ballots in two different schools at Columbia Universiy, asking them to rank the importance assigned to all binary contests on the ballot; and to indicate where they would have cast an additional bonus vote, had one been available. An identifier connected responses and actual voting choices allowing us to construct distributions of intensities and electoral outcomes, both without and with the bonus vote. With only two independent sets of simultaneous elections, the results provided some support for the theory, but two data points were too few to see cases where the bonus votes would have overturned the plurality choice. In this paper we use bootstrapping techniques to approximate the underlying distribution of valuations and estimate the probable impact of the bonus vote in the two sets of elections, using four alternative plausible rules for casting the bonus vote. We find the probable impact of the bonus vote to be nihil when majority voting works well, and positive when the intensity of preferences is stronger on the losing side of a contest, a situation majority voting has difficulty handling.

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1 Introduction

Theory suggests that individuals voting simultaneously over multiple binary proposals would benefit from being granted, in addition to their regular votes, a bonus vote. The bonus vote allows them to single out the issue they consider their highest priority and typically increases ex ante utility. In addition, in the presence of a minority that is systematically on the losing side of most elections, the bonus vote increases the probability that such a minority may occasionally win, and thus increases fairness and representation with little or now cost to efficiency.

The theory has not been tested in large elections, but there are two main reasons why it should be. First, the theoretical effects depend on the distributions of valuations in the population, but it is not clear either what assumptions should be made about these distributions, nor how robust the results should be to the shape of the distributions. Second, when we assume tractable distributions, the equilibrium strategies are relatively simple, but even in these cases the theory makes strong demand on voters' information and rationality. What would voters actually do in realistic situations where information is likely to be sparse, and rationality uneven? What would the welfare properties of the bonus vote be then?

In the Spring of 2006, we attached a short survey to students' election ballots in two different schools at Columbia Universiy, asking them to rank the importance assigned to all binary contests on the ballot; and to indicate where they would have cast an additional bonus vote, had one been available. An identifier connected responses and actual voting choices, allowing us to construct distributions of intensities and electoral outcomes, both without and with the bonus vote.

With two independent sets of simultaneous elections, we had only two realizations on which to evaluate the impact of the bonus vote, too few to form an estimate of the bonus vote probable impact. But the data could be boostrapped, allowing us to approximate the underlying distribution of preferences from which our sample was drawn. We postulated four alternative rules governing the use of the bonus vote, including boostrapping the original answers in the sample, and for each of these rules formed estimates of the bonus vote impact. We studied four different measures: (1) the probability that the bonus vote affects the electoral outcomes; (2) the probability that it leads to an efficient choice, compared to majority voting; (3) the difference in expected welfare, with the bonus vote and with simple majority voting, and (4) the impact of the bonus vote on measures of inequality of realized political preferences, and thus of representation. Our main result is that the bonus vote would have worked well: in term of all four measures and for all four of our rules governing how the bonus vote is cast, the probable impact of the bonus vote is nihil when majority voting works well, and positive when the intensity of preferences is stronger on the losing side of a contest, a situation majority voting has difficulty handling.

The paper proceedes as follows. In section 2 we discuss briefly the theory behind the idea of granting a bonus vote in large elections; in section 3 we describe the design of the experiment, and in section 4 the data we collected. In section 5 we study how the respondents of our survey said they would cast the bonus vote, and develop a simple statistical model. In section 6, we describe the bootstrapping exercise ond its results. Section 7 concludes.

2 The Theory

We begin by summarizing briefly the predictions of the theory on the use of storable votes in large elections. The focus is on several contemporaneous binary elections, where voters are asked to fill several positions, and in each case must choose between two candidates. In contrast to more traditional models of elections, where a single vote takes place to choose one or more winners among several candidates, we study multiple elections occurring at the same time, but where each election is binary. Thus the complications that arise in multi-candidate elections are absent here. The theoretical results described in this section are discussed in Casella and Gelman (2005), where the model is phrased in terms of contemporaneous referenda over several proposals, each of which can either pass or fail. Here, in line with Columbia students elections, the two outcomes of each election are labelled as two different candidates.

A large number n of voters are asked to vote, contemporaneously, on a set of k unrelated elections (with $k > 1$). Each election E_r is between two candidates, a_r and b_r, with $r = 1, .., k$. Voters are asked to cast one vote in each election, but in addition are given one bonus vote worth θ regular votes to cast freely over any of the elections. We call voter i's *valuation* in election r, denoted by v_{ir}, the voter's differential utility from having his or her preferred candidate win the election. Thus voter i's utility from election r is normalized to 0 if i's preferred candidate loses, and to v_{ir} if i's preferred candidate wins. Voter i's utility function is then $U_i = \sum_{r=1}^{k} u_{ir}(E_r)$ where $u_{ir}(E_r) = v_{ir}$ if $\acute{\imath}$'s favorite candidate wins E_r, and 0 otherwise.

Individual valuations are drawn, independently across individuals and across elections from probability distributions $\mathbf{G} \equiv \{G_{cr}(v),\ c = a, b;\ r = 1, .., k\}$ that can vary across candidates and elections but are common knowledge. Each individual knows his or her own valuation over each election, but only the probability distribution of the others' valuations. There is no cost of voting. We focus on symmetrical Bayesian equilibria in undominated strategies where, conditional on their set of valuations, all voters select the same optimal strategy. Since there can be no gain from voting against one's preferences, in these equilibria voters vote sincerely. The only decision a voter needs to make is on which election to cast the bonus vote.

Voters' valuations summarize the intensity of their preferences. Because storable votes are designed exactly to recognize and reward intense preferences, the properties of the mechanism and the welfare comparison to simple majority voting depend on the distributions of these valuations.

Call p_r the ex ante probability that a voter supports candidate a in election r. Consider first symmetrical environments, where the distributions of valuations of the two candidates' supporters are equal in each election ($G_{ar} = G_{br} \equiv G_r$) and the probability of support for either candidate is either known and equal to 1/2 ($p_r = 1/2$) or unknown but drawn for each election from some probability distribution H_p symmetric around 1/2. Then we can establish three results:

1. If the distributions of valuations are identical across elections, in equilibrium each voter casts the bonus vote in the election with highest valuation.
2. If the distributions differ across elections, then each voter chooses where to cast the bonus vote weighing negatively the relative saliency of the election: If others are disproportionately likely to cast their bonus vote in election s, then voter i casts the bonus vote in E_s only if $v_{is} \geq \alpha_{sr} v_{ir}$ for all r where $\alpha_{sr} > 1$ for all r and s.
3. For all distributions G and any number of elections $k > 1$, there exists a $\widetilde{\theta}(G, k) > 0$ such that ex ante expected utility with storable votes is higher than ex ante expected utility with simple majority voting for all $\theta < \widetilde{\theta}$.

The two considerations a voter takes into account are the relative intensity of his preferences over the different elections, and the expected impact of the bonus vote on the probability of being pivotal. When all distributions of valuations are identical the only consideration is the first; when they differ across elections, the second consideration plays a role too. Because ex ante in each election the two candidates are equally likely to win, the only characteristic differentiating the impact of the bonus vote is the saliency of the election itself: the expected impact of one's bonus vote is larger the smaller the expected number of bonus votes cast by others.

The ceiling on θ arises because the introduction of the bonus vote creates noise and redistributes the probability of winning towards the election where the bonus vote is utilized but away from the others. The extent of this shift in the probability of winning depends on θ. The expected wedge between the highest valuation and all others depends on the distribution G: if the wedge is large, the higher probability of being on the winning side is enjoyed in an election that really matters to the voter, and the loss in influence over the other elections is not very costly: the ceiling $\overline{\theta}$ can be large. If, on the other hand, all decisions are of approximately similar importance, then $\overline{\theta}$ will be lower. In the experiment described in this paper, we set $\theta = 1$: the bonus vote is equivalent to a regular vote. Result number 3 can then be read as saying that the addition of the bonus vote is expected to lead to welfare improvements if the wedge between the highest valuation and all others is sufficiently high, where the required threshold depends on k only, if distributions are identical, and on the distributions themselves otherwise.[1]

If the environment is symmetrical, the results are clean and quite simple. But symmetry is a very strong assumption and minimizes the importance of

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[1] For example, if distributions are identical, the required wedge between the expected highest valuation and the mean is 24 percent for $k = 3$ and 29 percent for $k = 4$, the two cases that are relevant in this paper.

the voting system: in each election, if the support for the two candidates is summarized in identical distributions of valuations, then the gain in efficiency that any voting rule can provide over a random choice of the winning candidate become vanishingly small if the number of voters is large. Allowing for asymmetries is important, but how should they be introduced? The model intends to capture two different dimensions: the *extent* of the support for each candidate, summarized by the probability of support p_r, and the *intensity* of such support, summarized by the distributions of valuations $\mathbf{G}$. Thus two types of asymmetry can be relevant here. To keep matters simple, suppose that p_r is known. Then:

4. Suppose that all distributions $\mathbf{G}$ are identical, but $p_r \neq p_s$ for all r, s. Then in equilibrium all voters cast their bonus votes in election s where $|p_s - 1/2|$ is minimal. For all G, k and θ ex ante expected utility with storable votes is identical to ex ante expected utility with simple majority voting and both voting rules are ex ante efficient.

5. Suppose $p_r = p = 1/2$, but $G_{ar} = G_a \neq G_{br} = G_b$ for all r. In particular suppose that G_a has higher mean than G_b:$Ev_a > Ev_b$. Then in equilibrium each voter casts the bonus vote in the election with highest valuation. For all G_a,G_b, k and θ ex ante expected utility with storable votes is higher than expected utility with simple majority if ex ante a voter's highest valuation is expected to be on a candidate of type a.

Majority voting is designed to capture asymmetries in the extent of support and in such situations is ex ante efficient. Storable votes then replicate the majority voting outcome. When the asymmetry comes from the intensity of support though, majority voting, which gives no weight to intensities is not ex ante efficient. Storable votes is efficient if the bonus votes are cast disproportionately in favor of the candidate who commands more intense preferences. It is possible to construct examples where this condition is violated, but it is not easy to do so, and typically storable votes will lead to higher ex ante welfare than simple majority voting. In the presence of asymmetries, the differences in welfare are not vanishingly small, even for very large populations.

Results 4 and 5 are interesting, but again come short of characterizing the properties of storable votes in realistic situations, where both types of asymmetries are likely to be present at the same time. We want to study environments where both extent and intensity of support for each candidate differ, and they differ both across candidates and across elections. It is very difficult to say anything general in such cases: equilibrium strategies will depend on p_r and on the exact shape of the distributions of valuations, and will put severe demands on voters' information and rationality. This shortcoming of a purely theoretical analysis is a large part of our motivation for running this experiment: what shapes do these distributions of valuations take in practice? What strategies do voters follow? How do storable votes compare to majority voting in this case?

3 The Experiment

In the Spring of 2006, we attached a questionnaire to the students' government elections held at Columbia University. The goal was to study storable votes in a real, if minor, political environment. Although the mechanism would not be used in the actual voting, the survey allowed to ask voters' for their valuations and, within the limitations of any survey, construct distributions of valuations over all our respondents, study the strategies that voters indicated they would use in the presence of the bonus vote, and finally evaluate the effects that the bonus vote.

Several of Columbia's schools hold elections in the Spring, and the students' organizations and the deans at the School of General Studies (GS) and Columbia College (CC) agreed to collaborate with us.[2] In both schools, voters elected representatives for multiple positions: GS students voted on a total of 20 different elections, and CC students over 12. All voting was electronic, and at the end of the ballot students were invited to participate in our survey. In the GS case, interested students clicked on a link and were redirected to a web age containing the survey. Students' votes and their responses to the survey were saved under anonymous identifiers and were later forwarded to us by the bodies supervising the elections. In the CC case, the survey was on paper, because of logistical difficulties with the voting stations. At the end of their electronic ballot, students interested in answering the survey were given a number to be copied at the top of the paper questionnaire. The number allowed us to link their responses to their actual votes, again forwarded to us anonymously after the voting was concluded. Prior to the elections, students in both schools were informed about the survey through a school-wide email message, and through posters and fliers distributed widely throughout campus. Participants in the survey took part in a lottery whose prizes were iPods and $20 gift certificates at Barnes & Noble, and the lottery too had been widely advertised.[3]

The paper questionnaire for CC is reproduced in the Appendix, and mirrors the GS questionnaire.[4] In both schools, we selected the subset of elections with two candidates or two mutually exclusive party lists only - three elections in GS (Board President, Alumni Representative and International Representative), and four elections in CC (Executive Board, Senator - Two Year Term, Senator - One Year Term, and Academic Affairs Representative).[5] Understandably, the

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[2] Barnard College was also part of the original design. However, the binary elections on the Barnard ballot concerned 23 minor but lengthy constitutional amendments, all of which were approved almost unanimously. One example: *Amend the mission statement of the Student Government Association to read: "The Student Government Association of Barnard College is committed to reflecting the diversity of, addressing the needs of the student body as a whole while bringing the Barnard Community together around common concerns and interests."* (119 Yes; 31 No).

[3] The prizes were 2 iPods and 8 gift certificates for the CC lottery (with a potential electorate of 4,073; and 1 iPod and 5 gift certificates for the GS lottery (with a potential electorate of 1161 students).

[4] With one difference that we dicuss below.

[5] We excluded the elections for class presidents or representatives because they concern different subsets of the electorates. We also excluded two elections where one of the candidates

organizers of the elections were very concerned with keeping our interference minimal, and the questionnaire had to be very simple. We fixed the value of the bonus vote B to 1, and asked two sets of questions: first, how much the voter cared about the outcome of each of those elections, on a scale from 1 (not at all) to 10 (a lot); second, in which election the voter would cast a single additional bonus vote in support of his or her favorite candidate.

The answers to the first questions give us the strength of the respondent's preferences, and when matched to his or her actual choice of candidate allow us to retrieve a measure of the theoretical valuations v_i, combining both strength and direction of preferences. These constructed valuations are at the core of our analysis. Combining all answers, we derive distributions of valuations in each election. In line with the theoretical model, at the individual level, we interpret the valuations as measures of utility, and when aggregated over all respondents, as an utilitarian measure of welfare on which we base our efficiency considerations. Clearly, our measure of valuations is quite imperfect. Most problems (misunderstanding of the question, imprecision in the statements, insincere or thoughtless answers), are likely to yield non-systematic errors. But one in particular could be serious. To avoid interpersonal comparisons of utilities and ensure that each voter is given the same weight when evaluating welfare, the theory constrains all voters' valuations to be drawn from the same underlying distributions[6] For each individual, the intensity draws over all elections should be read as normalized by a common numeraire, and in the presence of multiple elections, the natural numeraire is the mean intensity over the universe of elections, which the model holds constant across individuals.[7] But when the valuations are elicited freely, as we do in our questionnaire, the voters' responses are unconstrained: a more enthusiastic personality may well assign high importance to all elections, and a more phlegmatic type have the opposite bias towards low scores. If such a bias is present, the enthusiastic respondents will be overweighted in our utilitarian measure of welfare, and if the bias is not consistent across elections - for example because more specialized elections attract disproportionately more engaged or more partisan voters - then some elections will similarly be overweighted relative to the others. We can correct the bias by normalizing the answers to the questionnaire and imposing the same mean on all respondents. Specifically, for each individual i we construct normalized valuations $\overline{v_{ir}} \equiv v_{ir}/\sum_{r=1}^{k} v_{ir}$. For each individual, normalized valuations sum up to 1 and have mean $1/k$. Whether the appropriate measure of valuations is provided by the actual responses to the questionnaire or by their normalized measures is not obvious. For all that normalized valuations have in their favor, we cannot rule out that intensities that are systematically different across individuals are in fact drawn from the same distribution: over the universe

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was accused of irregularities (and later disqualified)

[6] More precisely, to be drawn from G_{ar} with probaility p_r, and from G_{br} with probability $1-p_r$ in each election r.

[7] In fact, by imposing not only the same mean but the same distribution, the model forces the voters to adopt an equal scale and to organize the different elections according to a fixed ordinal ranking, with the same proportion of decisions in any given subinterval of the support.

of elections it could well be that some respondents consider student elections relatively more important than others do. And after all, non-normalized valuations are what we ask in the questionnaire. Thus in all that follows we will present efficiency measures for both "raw" valuations (the actual responses) and normalized valuations.

4 The Data

Out of a total of 1161 GS students, 476 voted in the GS elections, and of these 297 answered our survey; in the College, 2057 voted out of a potential electorate of 4073, and 644 answered the survey. After eliminating CC questionnaires that were either unreadable or unmatchable to actual voters, we cleaned the data according to the following criteria: (1) We assigned a valuation of 0 to any election in which a respondent abstained;[8] (2) we assigned a valuation of 1 to any election in which a respondent voted but left the ranking blank, and (3) we eliminated from the sample respondents who stated that they would cast the bonus vote in an election in which they in fact abstained. Because the College questionnaires were on paper, they were missing automatic completeness checks that the electronic program forced instead on the GS students. In particular, 9 CC respondents did not indicate where they would have cast the bonus vote. But choosing not to use the bonus vote could be a legitimate choice, and we left these respondents in the sample. After cleaning the data, we were left with 276 responses in the GS sample and 502 in the CC sample, or a valid response rate among voters of 58 percent in GS and 24 percent in CC.[9]

Most of the analysis will focus on our sample only, but it is natural to begin by asking how representative the elections' results in the sample are, relative to the population of voters. For the electorate as a whole, the data we have are the number of votes for either candidate in each election, and the number of abstentions. Table 1 compares them to the equivalent numbers in our sample. Both in the sample and in the population, abstention rates are calculated for each election for students who voted in at least one election, and thus do not reflect the fraction of students who did not take part in voting at all.

TABLE 1

General Studies

	President	Alumni Affairs	International Rep.
Abstention rate (electorate)	10	38	34
Abstention rate (sample)	2	27	24
Margin of victory (electorate)	12	2	28
Margin of victory (sample)	5	4	30

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[8] A plausible option logically, and the only one available because we could not sign the valuation.

[9] The fact that one of us was a popular GS student probably explains the remarkably high response rate among GS voters.

Columbia College

	Exec. Board	Senate-1	Senate-2	Alumni Affairs
Abstention rate (electorate)	6	11	14	18
Abstention rate (sample)	2	8	11	15
Margin of victory (electorate)	15	11	40	25
Margin of victory (sample)	19	10	46	8

In Figure 1 we ask whether our sample is randomly drawn from the population. We plot the abstention rate and the fraction of voters supporting the winner in the sample, together with confidence intervals, and in the population, for each of the elections in our two data sets (GS in Figure 1a, and CC in Figure 1b). Predictably, individuals in the sample have significantly lower abstention rates, particularly for GS, but among voters their support for the candidates is representative of the population's (with one exception, for which we have no explanation: the election of Academic Affairs representative in the College). In one election, Alumni Affairs in GS, the winner in our sample differs from the winner in the population, but the election was very close and the discrepancy falls within 1 standard error of the sample estimate.[10]

The distributions of valuations in our data sets are reproduced in Figures 2a (for GS) and 2b (for CC), with valuations labeled as positive or negative, according to which of the two candidates the respondent voted for. Consider for example the election for Board President in the GS sample. The corresponding distributions of valuations, raw and normalized, are represented in the two histograms on the upper left corner of Figure 2a. The valuations of Susannah's supporters are plotted on the positive axis; and those of Liz' supporters on the negative axis, while the cell at zero, in black, reports abstentions. The histogram of raw valuations has a support that runs between 0 and 10, for either candidate. It tells us for example that among the respondents who gave this election a score of 10, 23 voted for Liz and 31 for Susannah; among those who gave it a score of 9, 11 voted for Liz and 13 for Susannah, etc. The histogram of normalized valuations has support between 0 and 1, and, by construction, larger mass at intermediate values. Again by construction, voters at 1 or -1 cannot have voted in any other of our three binary elections, an observation that applies to 29 of Susannah's supporters and 18 of Liz'. The sum of valuations in favor of each candidate is reported below each histogram: 954 on Susannah's side, versus 810 on Liz' for raw valuations, and 80 on Susannah's side versus 68 on Liz' for normalized valuations. The histograms make clear that in our sample Susannah commanded both a majority of the votes and more intense preferences. The box below the histograms summarizes the information about

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[10] In the figures, we consider the fraction of abstainers and of supporters for either candidate in the population as the "true" values. The rates realized in the sample are then the best estimates of the population's value, with confidence intervals calculated in each case from standard binomial standard errors. Alternatively, we could ask whether both our sample and the full sample of voters are random draws from some underlying distribution, adding confidence intervals around the populations points in the plots and making rejection more difficult.

the election: in our sample of 276 students, 142 voters supported Susannah, 129 supported Liz, and 5 abstained: Susannah won a majority of the votes. As indicated by the much lower abstention rate, the election for president appears to have been the most important of the three elections in the GS survey, and 208 of our respondents stated that they would have cast the bonus vote in this election. We attributed the bonus votes according to each respondent's actual candidate choice, and Susannah again wins a majority of the bonus votes (110 against 98). Thus, in our sample, Susannah wins the election on the basis of simple majority; would have won it if bonus votes were used, and should have won it according to our efficiency measure, whether in terms of raw or of normalized intensities. Susannah did in fact win the election among all voters, with 241 votes in favor, versus 188 for Liz and 47 abstentions. The other histograms can be read in the same manner.

We can compare the three GS elections to one another on the basis of both Table 1 and the histograms. In our sample two of the three elections were very close, with margins of victory of 4 percent (Alumni Affairs) and 5 percent (Board President), while the third (International Representative) is clearly lopsided, with a margin of victory of 30 percent. Alumni and International have high abstention rates (above 26 and 24 percent, respectively) while President does not (below 2 percent). Average intensities across supporters of the two candidates are quite similar within each election, but differ across elections, again confirming the different relative importance assigned to the three elections. In terms of raw intensities, for both candidates the average is around 6.5 in the President election, 5 in the Alumni election, and 4.5 in the International election (the corresponding averages for standardized intensities are around 0.55 in the President election, 0.35 for Bob in the Alumni election, and 0.3 for Maria in Alumni and both Makiko and Liron in the International election). Finally, in all elections the efficient choice is unambiguous, whether in terms of raw or normalized valuations, and both simple majority and the bonus vote mechanism select it. In the President election and the International election, the majority winner commands a majority of the bonus votes; it does not in Alumni Affairs, but the difference is small (2 votes), and cannot override the difference in regular votes.[11]

Figure 3 presents the corresponding histograms for the four elections in the CC sample. None of the elections was as close as the tight GS contests and one was a clear landslide: in our sample, the margins of victory are 19 percent (Executive Board), 10 percent (Senate-1), 46 percent (Senate-2) and 8 percent (Academic Affairs). The differences in abstention rates are less pronounced than in the GS sample: there is again one election in which almost everyone voted (Executive Board, with an abstention rate below 2 percent), but the highest abstention in this sample is 15 percent (Academic Affairs), with 8 for Senate-1 and 11 for Senate-2. Average intensities confirm that the elections in this sample enjoyed more equal status, while instead differing between supporters

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[11] Note that this is the one election where the winner in our sample (Bob) was not the winner of the overall election.

of the two sides: there is again one contest where declared average intensities are clearly highest (Executive Board, with 6.5 for Open Columbia and 6 for Evolution, in raw terms), but the difference with respect to the other elections is less pronounced. Average raw intensity is 4.5 for David and 5 for Yie (Senate-1), 5 for Tiffany and 4 for Gerry (Senate-2), 5 for Alidad and 6 for Ehizoje (Academic Affairs). (With normalized intensities, the corresponding numbers are and 0.4 for open Columbia and 0.3 for Evolution, in the President election, 0.3 for Ehizojie in Academic Affairs and 0.25 for all other candidates).

In the CC sample, there are two elections where the average intensity is higher on the side of the losing candidate (Senate-1, for raw intensity only, and Academic Affairs, for both measures of intensity). If not compensated by a sufficiently large imbalance in the number of supporters, this is the type of preference pattern that can yield inefficiencies for majority voting, as indeed we observe in the Academic Affairs election: with raw intensities, the efficient candidate choice should be Ehizojie, while Alidad won a majority of the votes (with normalized intensities, the efficient criterion yields a tie)[12]. This is the one case where in our sample the majority choice is inefficient. The distribution of valuations shows clearly the origin of the problem: the valuations of Ehizojie's supporters, and not those of Alidad's supporters, are concentrated towards high values. It is not surprising then to see that the bonus votes would have favored Ehizojie too. However, the imbalance in bonus votes (8 votes) is again not sufficient to override the difference in regular votes, and thus in the CC sample too the bonus votes mechanism would have lead to the same results as simple majority voting.

Summarizing, in both data sets the distributions do differ across elections: some elections stand out as more important than the others; some distributions are approximately symmetrical, some are not, and the form the asymmetry takes again differs across elections. In our GS sample, two of the distributions are approximately symmetrical (President and Alumni), while the third (International) is asymmetrical. The asymmetry comes from the distinctly larger mass concentrated on one side, while the shape of the distribution is comparable on the two sides - the type of asymmetry majority voting is designed to handle, where intensity of preferences is not the issue. In the CC sample, one distribution appears approximately symmetrical (Senate-1); among the others, two have both larger mass and larger intensity on one side (Executive Board and Senate-2), but the third (Academic Affairs) shows the type of asymmetry that can be problematic for majority voting: a minority with more intense preferences.

Given the distributions of valuations, we can now ask how the bonus votes were cast in our survey.

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[12] The fact that Ehizoje's intensity advantage disappears when valuations are normalized suggests that Ehizoje's supporters on average gave higher rankings to to the other elections than Alidad's supporters did.

5 How Did Respondents Cast the Bonus Vote?

The natural reference is the theoretical equilibrium strategy: given the distributions of valuations and their own preferences, did respondents state they would cast the bonus vote as theory predicts? Unfortunately, this is not a question we can answer convincingly with the data we have. The theoretical equilibrium strategy depends on the *common knowledge* of the distributions of valuations *in the electorate at large*, because it is the choice of the electorate as a whole that any single voter is trying to influence. The distributions of valuations we construct from the survey refer to a sample only - the respondents of the survey. The actual outcomes of the elections allow us to compare the support for the two candidates in our sample and in the electorate at large, as we have done, but do not give us any basis for extrapolating the shape of the distributions of valuations to the electorate as a whole. Nor do we have any evidence that preferences were common knowledge. In fact we have some weak evidence to the contrary. In the GS questionnaire, electronic and thus faster, we added a question about expected election outcomes.[13] In the President election, more than 80 percent of the students filling the questionnaire answered the question, but about half of them predicted the wrong winner, and a quarter predicted that she would win by a large margin; in the other two elections, more than half of those filling the questionnaires chose not to answer the question, in line with the large abstention rate, but among those who did respond, a majority predicted the wrong winner in the Alumni Affairs election, half of them by a large margin, and one third did so in the International election. There answers may reflect something other that rational calculations of expected outcomes and probably should not be taken too seriously, but cannot be read as support for common knowledge of the full distributions of valuations.

Given our scarce knowledge of the voters' information, then, we do not attempt to test the equilibrium strategies. We use the intuitions from the theory to devise simple rules of thumb that voters could follow in choosing where to cast the bonus vote, and we describe the responses to the questionnaire through these rules of thumb.

The first question is whether voters in our sample said that they would cast the bonus vote on the election they ranked as most important. Overall, **xx** percent did so in the GS sample, and **xx** percent in the CC sample. Figures 3a for GS and 3b for CC show the relevant data, election by election. Each diagram reports, for all respondents who said they would cast the bonus vote on that specific election, the absolute valuation (the intensity score) assigned to that election, on the vertical axis, and to the highest ranked of the other elections, on the horizontal axis. If the election selected for the bonus vote is the highest intensity election, then the respondent is indicated by a point above the 45 degree line; if not, by a point below the 45 degree line.[14] We know from

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[13] This is the difference between the two questionnaires mentioned earlier.

[14] The figure is in terms of raw intensities, but because the only relevant information here is the ordinal ranking of the elections, normalized intensities would yield a rescaled but otherwise identical figure.

the previous figures that the most salient election in both data sets (President in GS and Executive Board in CC) received the great majority of the bonus votes; Figure 3 tells us that it was also the election most respondents ranked as most important to them. In all elections, some bonus votes were cast by respondents who ranked a different contest as more important to them. The number of such bonus votes is relatively small in both the GS President election and the CC Executive Board election, but less so, in relative terms, in the other elections. The bonus vote choice does not seem to correlate in any transparent manner with the realized margin of victory. In the GS data set, the closest election was Alumni Affairs, with a margin of 2 percent, but the fraction of voters who cast the bonus vote in that election while ranking a different one as more important to them is very similar to the fraction in the International election, the most lop-sided, with a margin of victory of 28 percent. In the CC data, the pattern is similar, although the fraction of voters casting the bonus vote in the closest election (Senate-1, with a margin of victory of 11 percent) while ranking a different election higher is marginally larger (**numbers**).

5.1 A Simple Statistical Model

The probable lack of information about other voters' preferences and the regularities we see in the data suggest describing the respondents' bonus vote choice through a set of simple behavioral criteria. Each criterion specifies how to cast the bonus vote, and each respondent's answer, given his valuations, can be written in terms of the probability of following the different criteria. We posit four mutually exclusive criteria: (1) cast the bonus vote on the highest valuation; (2) cast the bonus vote on the most salient election; (3) cast the bonus vote on the closest election; (4) some other rule we ignore, and such that the choice appears to us fully random. We suppose that each criterion is followed with some probability, which we call $p\max$ for rule 1, $psal$ for rule 2, $pclose$ for rule 3 and $p\,\mathrm{rand}$ for rule 4, and we describe a respondent's choice through these probabilities. For example, consider a GS voter whose highest valuation is on the President election, and who indicates that he would cast the bonus vote on that election. Under our model, this behavior occurs with probability $p\max + psal + (1/3)p\,\mathrm{rand}$. If the voter assigns the highest valuation also to a second election, then the probability of the observed behavior becomes $(1/2)p\max + psal + (1/3)pran$, and correspondingly for the other cases. Assuming that respondents' choices are independent, the likelihood of observing the data set is simply the product of the probabilities of all individual choices. The probabilities $p\max$, $psal$, $pclose$, and $p\,\mathrm{rand}$ can then be estimated immediately through maximum likelihood or bayesian methods.

We have estimated the probabilities on the two data sets separately, and in both cases maximum likelihood and bayesian estimation yield identical results, summarized in Table 2, with standard errors are in parentheses.[15]

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[15] **Details of the estimation.**

Table 2

	GS	CC
pmax	0.55 (0.06)	0.52 (0.04)
psal	0.34 (0.06)	0.30 (0.04)
pclose	0.01 (0.01)	0.04 (0.01)

In both data sets and with both estimation methods, *psal*, the probability of casting the bonus vote on the most salient election, is relatively large and significantly different from zero. At the same time, *pclose*, the probability of casting the bonus vote on the election with smallest margin of victory, is always very small and in the GS sample insignificant. The two results are puzzling: everything else equal, the marginal impact of the bonus vote should be larger in close elections and smaller in salient elections, suggesting the opposite pattern from what we see in the data. But again we know too little about the voters' information to interpret these regularities as evidence of voters' irrational behavior. First of all, respondents may have been unclear about the precise meaning of our questions. We asked how important the outcome of any of the election was to them, and some of the voters may have interpreted the question narrowly, as asking how partisan they felt over an election. But their overall valuation, and their decision of where to cast the bonus vote, would give weight to the importance of the position too. Second, the two most salient elections were also reasonably close elections, the second closest in both data sets, and attracted much more debate and attention prior to voting than any of the others. It is possible that voters chose them disproportionately because in fact they knew them to be close contests, while they had very little information about the Alumni Affairs election in GS and the Senate-1 election in CC, the two elections where at the end the margin of victory was smallest.[16]

The statistical model we have posited is extremely simple. In particular, the probabilities with which the different rules are followed are seen as exogenous parameters, and not allowed to depend on the voter's full set of valuations: a voter's valuation in a given election can be maximal but very close to the voter's valuations in other elections, suggesting that saliency or closeness will influence the choice of bonus vote; or on the contrary the maximal valuation can be very different from the other valuations, overshadowing other considerations. The model could be enriched, but we have not done so because we do not think of the model as providing a test for the theory. Its only role is to describe synthetically the patterns we see in the data, giving us a concise approximation of the behavior of the survey's respondents. We use this approximation, among others, in the boostrapping exercise that forms the rest of this paper.

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[16] We have some weak evidence supporting this second observation. In the GS questionnaire, respondents to our question about expected electoral outcomes were closely divided in predicting victory for either of the two candidates in the President election (with a margin of 5 percent among those who answered the question), but much less so in the Alumni Affairs election (with a margin of 20 percent among those who answered). We should also add that this latter advantage was in favor of the candidate who in fact lost the election, suggestiong once again the lack of information about less important contests.

6 Bootstrapping the Data: Repeating the Elections 10,000 Times.

The central question we want to ask is whether adding a bonus vote to the set of binary elections is likely to improve or to reduce welfare, given the strategies that voters employ. In our sample, no outcome would have been changed by the addition of the bonus vote: as we have seen, there are only two elections, Alumni Representative in GS and Academic Affairs in CC in which bonus votes favor the minority candidate, and even in those the advantage in bonus votes falls short of what would overturn the majority's choice (Maria has an advantage of 2 bonus votes in Alumni, against a disadvantage of 9 regular votes, and Ehizoje has an advantage of 8 bonus votes in Academic Affairs, against a disadvantage of 35). However, the observed lack of impact in our data is not too surprising: we have a single realization of a set of elections in each data set, and thus two realizations in all. The probability that the bonus vote changes the outcome of an election is likely to be small. According to the theory, in elections that are clearly lop-sided the bonus vote will not, and should not, change the outcome; in elections that are very symmetric, the bonus vote may affect the outcome, but the probability will not be large (**example**). Where the bonus vote may matter is when realized preferences are heterogeneous enough to have dispersion in priorities, and in at least one election large intense minorities are matched by lukewarm majorities. Ex ante, we cannot assign a probability to such a realization of preferences because it depends on the primitive distributions of valuations, on the number of elections, and on the number of voters. But overall the likelihood of seeing the bonus vote changing an outcome over two realized sets of randomly chosen elections seems small.

On the other hand, the data do provide us with information that we should be able to exploit. Ideally, we would want to replicate the same Columbia elections many times, with many different electorates whose preferences are all drawn from the same underlying distribution of valuations. The goal is to approximate the underlying distribution itself, and assess the probable impact of the bonus vote on electoral outcomes and welfare, given the underlying distribution. We cannot rerun the elections many times, but we can bootstrap our data.

The central assumption we exploit in our bootstrapping exercise is that preferences are independent across individuals. We are less confident about preferences' independence across elections for a single individual, and thus we chose to proceed without imposing this second form of independence. First, we sample with replacement n individuals from our data set, where $n = 276$ for GS and $n = 502$ for CC: by "sampling an individual" we mean that we sample the individual's valuations over all elections and his decision on the bonus vote. Second, we replicate this procedure 10,000 times, where each replication generates distributions of valuations over all elections in the set (3 for GS and 4 for CC), and a bonus vote choice for each voter. Finally, for each replication, we study the set of elections. We calculate outcomes and our utilitarian measure of welfare (with both raw and normalized valuations) if the elections were held with simple majority voting, and with four alternative rules governing the use of the bonus vote. Rule A is closest to the data: we use the bonus vote choice actually made by the individuals sampled in the bootstrapping; rule B estimates each individual's bonus vote decision by applying our statistical model to the realized distributions of valuations; rule C has each voter casting the bonus vote on his highest valuation; rule D corrects for the presence of very lop-sided elections - International in GS and Senate-2 in CC - where the bonus vote is almost certainly wasted, and specifies that an individual casts the bonus vote on the highest valuation, unless this is one of those two elections.[17] All behavioral rules keep voters' strategies fixed, and independent of the realized distributions of valuations (although it is true that de facto the distributions generated by boostrapping do not vary greatly). Once again, we do not attempt to test or mimic equilibrium behavior, but rely on the comparison of four different, plausible rules of thumb to evaluate the robustness of the conclusions we reach.

6.1 How often does the bonus vote change the outcome?

As we discussed, the probability that the bonus vote has an impact on the elections depends on the distributions of valuations and cannot be pinned down a priori. The simulations allow us to form an estimate, for the underlying distribution from which our data set is drawn. Figure 4 shows the frequency with which at least one of the elections' winners changes when the voting system switches from simple majority to storable votes, together with the frequency's confidence interval of +/- 2 standard errors. Figure 4a reports the results for the GS simulations, and Figure 4b for CC. For each data set there are four results, each corresponding to a different rule determining how the bonus vote is cast. We report the aggregate number - the frequency with which at least one election changes over the whole of three, for GS, or four, for CC, elections because the bonus vote works exactly by bundling the set of elections and its impact should be evaluated over the whole bundle.

In the GS data, the frequency is relatively stable across the different rules and takes values between 13 and 17 percent. Surprisingly, rule B (the model) yields a significantly lower frequency, while the other three rules are in agreement over a slightly higher number (between 14 and 17 percent). The aggregate number reported in the figure derives from very different impacts on the specific elections: in the International election the outcome never changes; it changes between 5 and 8 percent of the times, depending on the bonus vote rule, in the President election, and between 7 and 11 percent in the Alumni election. Predictably, these frequencies reflect the different symmetry of the distributions of valuations over each election, both in terms of the mass of voters supporting each candidate and of the intensity of such support. Although the realized

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[17] In the data, the International election in GS has a margin of victory of 30 percent, and the Senate-2 election in CC of 46 percent. In the simulated data sets the margins of victory vary, but in all 10,000 data sets they remain large (**details**) and for all three rules A, B and C the bonus vote never changes the outcome and the outcome is always efficient.

distributions are generated anew for each simulation, they are constrained by the draws of our actual data set, and the description of the sample draws in section x provides the best intuition for the results discussed here.

In the CC data, the frequency with which the outcome is affected by the bonus vote differs significantly between the first two rules (A and B) and the latter two (C and D). With rules A and B, the frequency is between 8 and 11 percent; with rule C between 20 and 22 percent, and with rule D between 25 and 27 percent. The reason is not difficult to see: in the data and in the statistical model (rules A and B) a significant fraction of the bonus votes are cast on the most salient election, Executive Board, even when it does not correspond to the highest valuation. But the Executive Board election has both a strong majority and more intense preferences in favor of the winning candidate, with the result that in our 10,000 simulations bonus votes never change its outcome. With rules C and D, on the other hand, bonus votes are cast on Executive Board candidates only if the election evokes the highest valuation, and more bonus votes are then available to change the outcome of the other contests. The Executive Board election is a certain victory for Open Columbia, but, as we discussed earlier, the most lop-sided election in our data is a different one: Senate-2. In addition to reducing the number of bonus votes cast for Executive Board, rule D also excludes bonus votes on the Senate-2 election. The still higher number of bonus votes available for Senate-1 and Academic Affairs results in the highest frequency of changed outcomes. The disaggregated frequencies are in line with this discussion. Outcomes never change for Executive Board and Senate-2; they change rarely in Senate 1 (between half a percent of the times, with rules B, C and D, and a maximum of 2 percent with rule A), but quite frequently for Academic Affairs (about 9 percent of times with rules A and B, 21 percent with rule C and 26 percent with rule D). The Academic Affairs election combines similar extent of support for the two candidates with dissimilar intensities, and thus is the most likely to be affected by the existence of bonus votes.

6.2 Probability of selecting the efficient outcome

Having learnt that the bonus vote has the potential to affect the outcome of the elections, is the change towards a more efficient or a less efficient result? Figure 5 plots the frequency with which the outcome selected by the voting system maximizes our utilitarian measure of welfare, for both raw and normalized valuations, and for both majority voting and storable votes. The aggregate frequency is calculated over all elections in all simulations. The qualitative results do not change whether we evaluate efficiency in terms of raw or normalized valuations, but in both data sets the difference between majority voting and storable votes, and among the different rules for casting the bonus vote, are sharper with normalized valuations. Here we describe the results when valuations are normalized.

In the GS simulations, majority rule is efficient between 91 and 92 percent of the times, a very similar frequency to that obtained with the bonus vote under rule B (the statistical model). Rule C, and particularly rule D yield slightly better results, with a frequency of efficient outcomes between 92 and 94 percent. Rule A, on the other hand, where votes are bootstrapped, is inferior, with an efficiency rate between 89 and 90 percent. We have no good explanation for the difference between rules A and B, although we know that it is driven by the low frequency of efficient outcomes in the Alumni election under rule A: 78 percent versus 84 with rule B. When looking at the results election by election, all bonus vote rules outperform majority voting in the President election, while doing worse, with the exception of rule D, in the Alumni election. (As we discussed, no outcome ever changes in the International election).

In the CC data, all bonus vote rules are superior to majority voting, and significantly so. Majority voting is efficient about 90 percent of the times, versus 92 percent for rule B and C, 95 for rule C and 96 for rule D. As we would expect, rules A and B yield almost identical results; rules C and D are instead significantly superior to A and B, and D is significantly superior to C. The results are driven by the performance of the voting rules in the Academic election, the most sensitive to the addition of the bonus vote and the most frequently inefficient under majority voting. Majority voting is efficient only about 62 percent of the times, versus 71 percent for the bonus vote with rules A and B, 82 percent with rule C and 86 percent with rule D.

6.3 Welfare

The frequency of efficient outcomes begins to address the impact of the bonus vote on welfare, but gives us only the direction of the change, without taking into account the quantitative weight that welfare gives to that change. In other words, efficiency could be achieved in elections where the difference in total valuations between the supporters of the two candidates is small, and lost in fewer cases, but where conceivably the cost if inefficiency is larger. A priori, the frequency of efficient outcomes could increase, and yet welfare decline.

In each election, welfare is defined as the sum of valuations of all voters who supported the winner. With storable votes, the relevant unit is the set of elections, and thus the measure of welfare we study aggregates welfare for each election over the three, for GS, or four, for CC, elections that constitute one set. To express the measure in units that are intuitively meaningful, we divide it by full efficiency (welfare when the efficient outcome is always selected) and scale both numerator and denominator by expected welfare when either candidate wins each election with probability 1/2, i.e. when outcomes are chosen randomly, a plausible welfare floor. If we call W_S welfare under voting system S, W^* welfare under efficiency, and R expected welfare with random outcomes, our final welfare measure then is $\Omega \equiv (W_S - R)/(W^* - R)$, and expresses the share of available surplus, over randomness, that voting system S succeeds in extracting.

Figure 6 reports the mean welfare measure over the 10,000 simulations for GS (Figure 6a) and CC (Figure 6b), for both raw and normalized valuations, together with the 95 percent confidence interval, calculated directly from the distribution of the welfare measure in the 10,000 simulations. The results confirm the tendencies shown in Figure 5, when reporting the frequency of efficient outcomes. In GS, mean welfare with storable votes is higher than mean welfare with simple majority for rules B, C and D, but lower for rule A. In all cases, the differences are small: a decline of 1 percent of surplus between majority and bonus vote-rule A, an increase of less than 1 percent between majority and rule B, an increase of 1 or 2 percent with rules C and D, depending on whether we consider raw or normalized valuations. In CC, all bonus vote rules lead to higher mean welfare than simple majority. The improvements are between 1.5 and 4 percent of surplus with raw valuations, and between 1 and 2 percent with normalized valuations. As in the case of Figure 5, the results are very similar across rules A and B, and rules C and D, and superior for the latter pair.

None of the differences in mean welfare is statistically significant. But this is something we already knew: if the bonus vote changes the outcome of a set of elections at most 25 percent of the times, then the difference in welfare must be exactly zero at least 75 percent of the times, and any confidence interval including more than 25 percent probability includes zero necessarily. The interesting question is a different one: *when the bonus vote leads to a result that differs from majority voting*, is the change towards more or less efficiency?

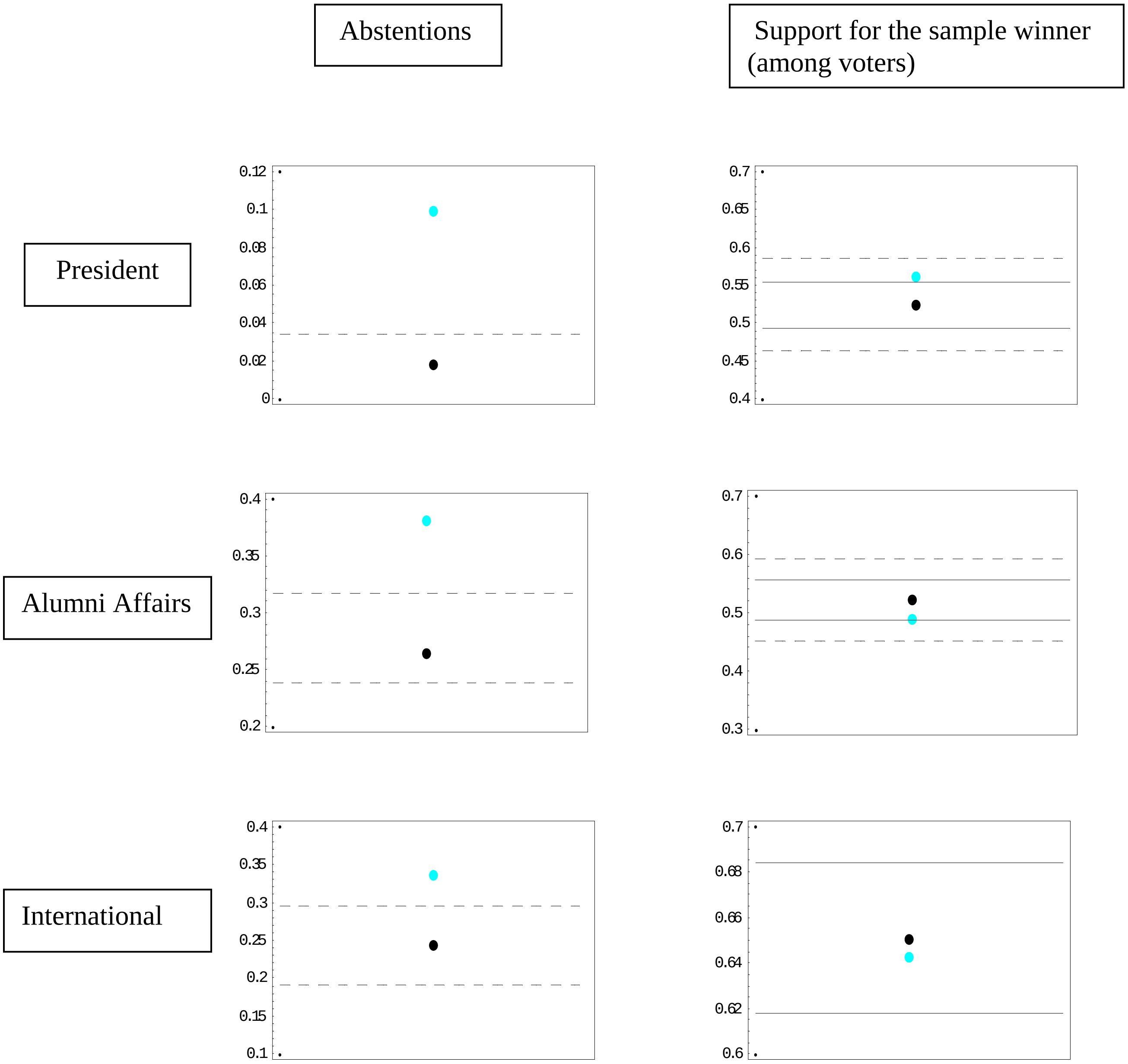
In figures 7a (for GS) and 7b (for CC), we plot the distribution of the difference in the welfare measure between each bonus vote rule and majority voting over the 10,000 simulations, for both raw and normalized valuations. At the top of each histogram, we report the probability that the difference is positive, or the total probability mass on positive values. Confirming the previous results, in GS, rule A performs more poorly than any of the others, and is the only one for which the bonus vote decreases welfare more often than it raises it. However, for all four rules there is always substantial probability that the difference in income can assume either sign, and at conventional confidence levels, the mean welfare difference is never significantly different from zero. The bonus vote has very little or no impact on welfare in the GS sample. The conclusion confirms the original observations on the distributions of valuations in our sample: the distributions are such that majority voting should work well, and the asymmetries that are present arise from differences in the extent of support between the two candidates of each election, as opposed to the intensity of such a support. Majority voting works well, and the bonus vote does not change matters substantially.

In the CC data the conclusion is different. It remains true that rule A is the one performing least well, but the probability that the bonus vote improves welfare is much higher. With raw valuations, the probability of an improvement is 97 percent for rules A and B, and 99 percent for rules C and D, with the bonus vote providing a mean increase in welfare of about 15 percent of available surplus, with little difference across the four rules. With normalized valuations, the probability is 88 percent with rule A, 94 with rules B and D and 96 percent with rule C, and the mean increase in welfare is around 8 percent for all rules. Again, the results confirm what the original description of the distributions of valuations had shown: the intense minority preferences in the Academic Affairs election created the potential for a positive role for storable votes.

6.4 Inequality and representation

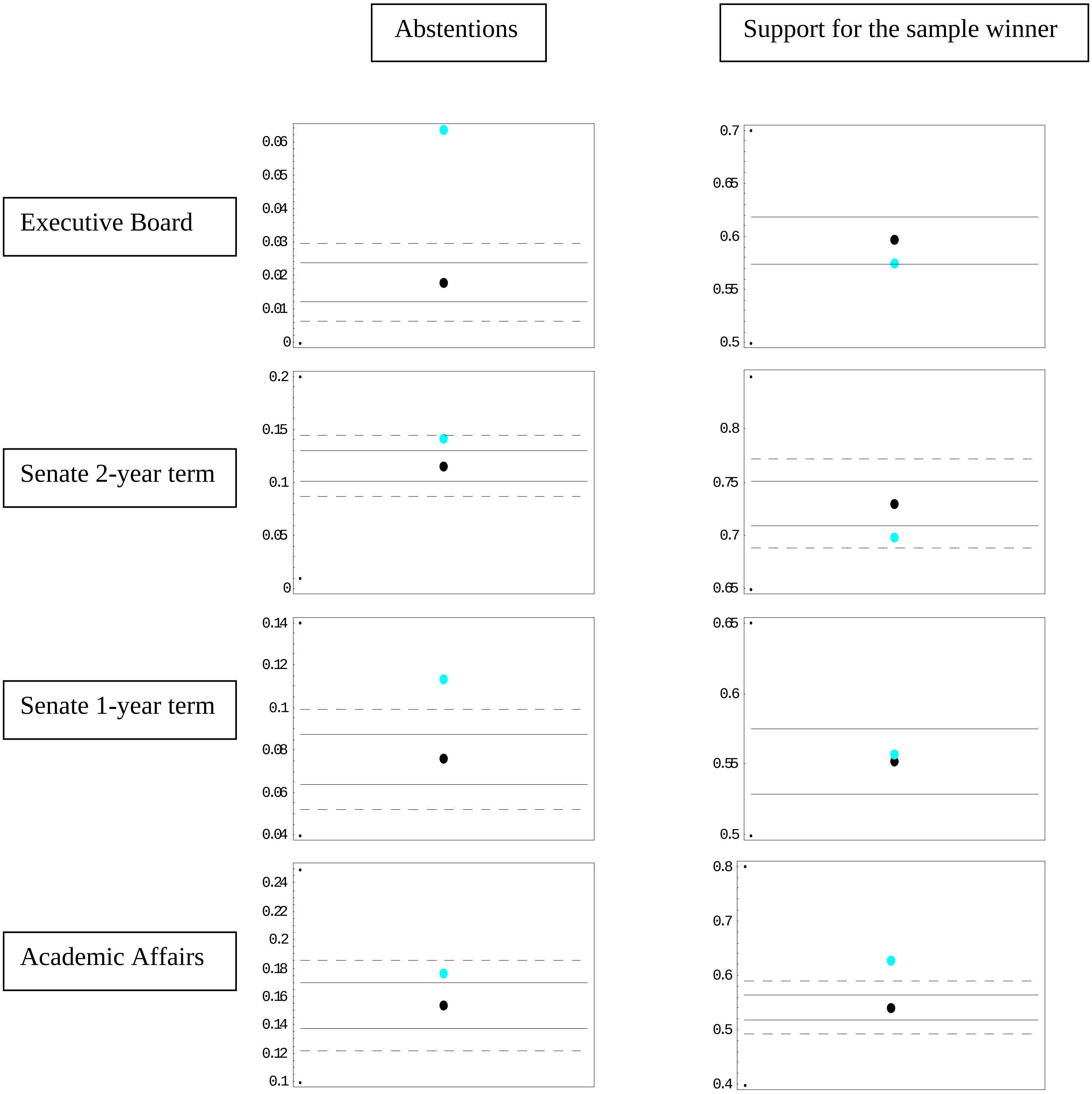
FIGURE 1
RANDOM SAMPLE TEST

Figure 1a: General Studies



The black dot is the sample point; the grey dot is the population point;
The solid line is +/- 1 standard error; the dashed line is +/- 2 standard errors.
N=476; n=276.

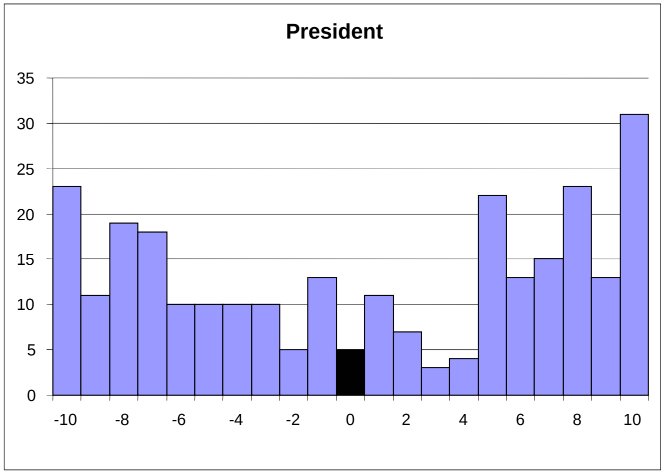
Figure 1b: Columbia College



The black dot is the sample point; the grey dot is the population point;
The solid line is +/- 1 standard error; the dashed line is +/- 2 standard errors.
N=2057; n=502.

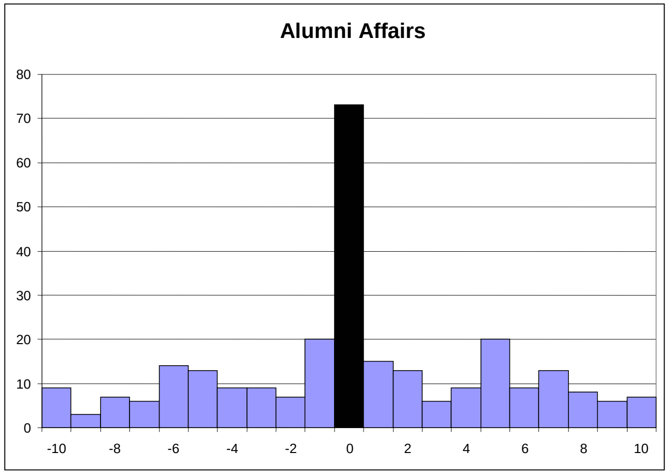
SAMPLE: N=276. ELECTION: N=476

SCHOOL OF GENERAL STUDIES



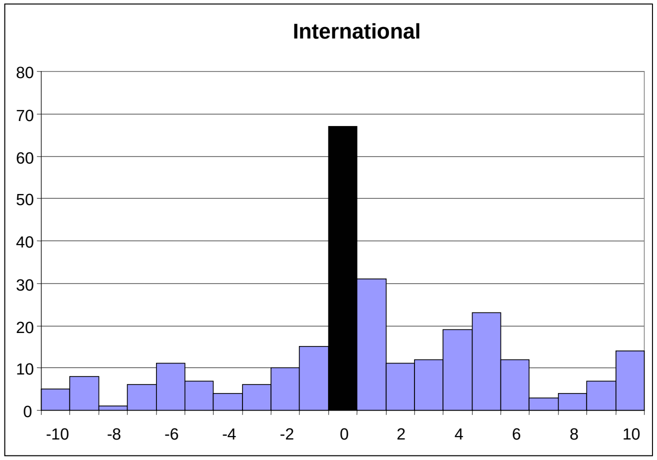
Susannah >0
Outcome: Susannah 142; Liz 129; Abs 5
Bonus Votes: Susannah 110; Liz 98
Intensity: Susannah 954; Liz 810

ELECTION: Susannah 241; Liz 188; Abs 47



Bob >0
Outcome: Bob 106; Maria 97; Abs 73
Bonus Votes: Bob 17; Maria 19
Intensity: Bob 528; Maria 461

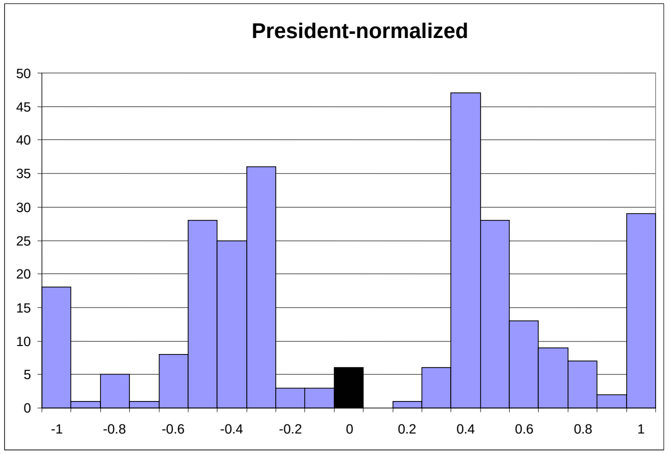
ELECTION: Maria 151; Bob 144; Abs 181

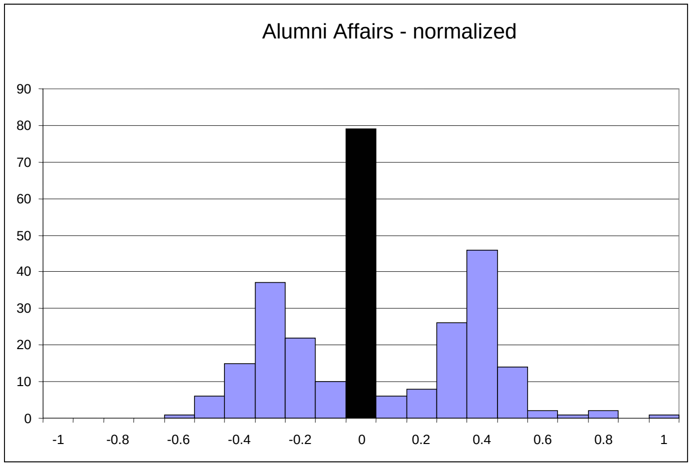


Makiko >0
Outcome: Makiko 136; Liron 73; Abs 67
Bonus Votes: Makiko 21; Liron 11
Intensity: Makiko 608; Liron 342

ELECTION: Makiko 203; Liron 113; Abs 160

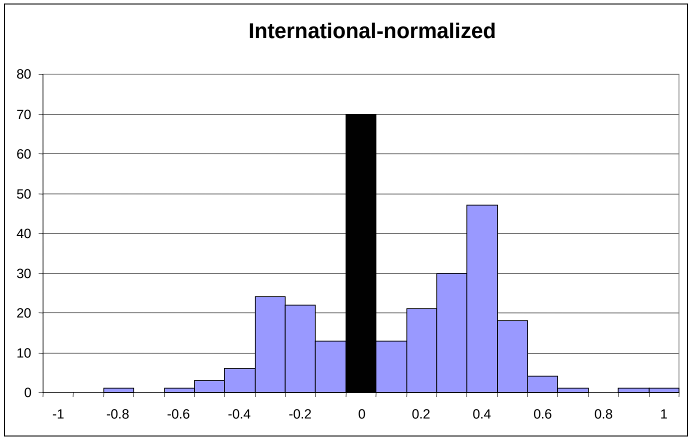
SCHOOL OF GENERAL STUDIES - NORMALIZED





Susanna >0
Outcome: Susanna 142; Liz 129
Bonus Votes: Susanna 110; Liz 98
Intensity: Susanna 80; Liz 68

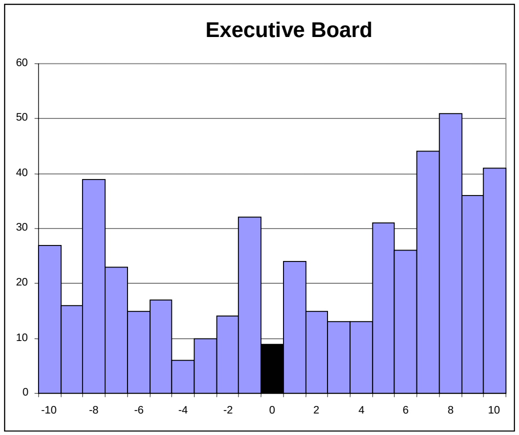
Bob >0
Outcome: Bob 106; Maria 97
Bonus Votes: Bob 17; Maria 19
Intensity: Bob 36; Maria 30



Makiko >0
Outcome: Makiko 136; Liron 74
Bonus Votes: Makiko 21; Liron 11
Intensity: Makiko 41; Liron 21

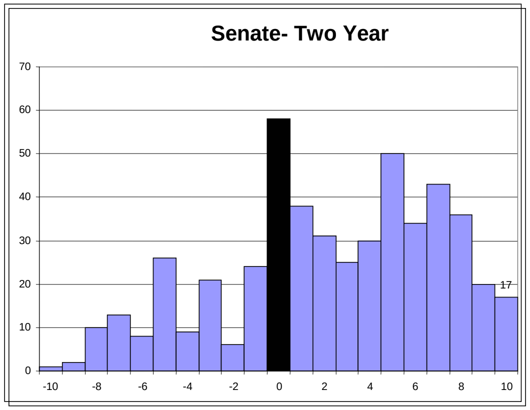
SAMPLE: N=502. ELECTION: N=2057

COLUMBIA COLLEGE


Executive Board

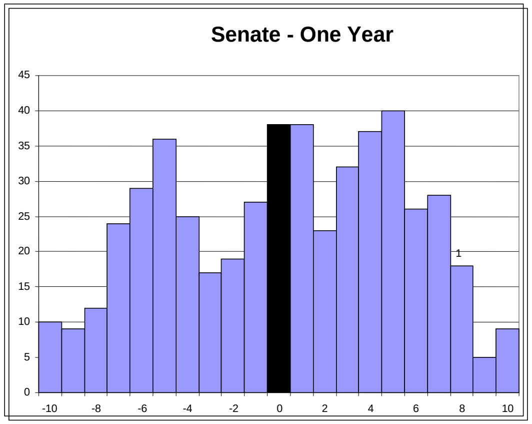
Open Columbia >0
Outcome: Open Columbia 294; Evolution 199; Abs. 9
Bonus Votes: Open Columbia 205; Evolution 105
Intensity: Open Columbia 1906; Evolution 1176

ELECTION: Open C. 1107; Evolution 819; Abs 131


Senate- Two Year

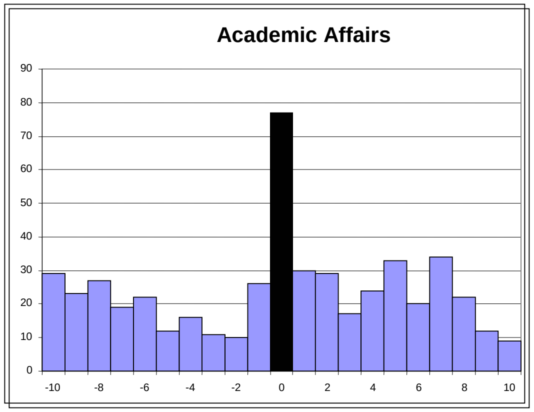
Tiffany >0
Outcome: Tiffany 324; Gerry 120; Abs 58
Bonus Votes: Tiffany 48; Gerry 9
Intensity: Tiffany 1688; Gerry 512

ELECTION: Tiffany 1233; Gerry 533; Abs 291


Senate - One Year

David >0
Outcome: David 256; Yihe 208; Abs 38
Bonus Votes: David 29; Yihe 29
Intensity: David 1159; Yihe 1015

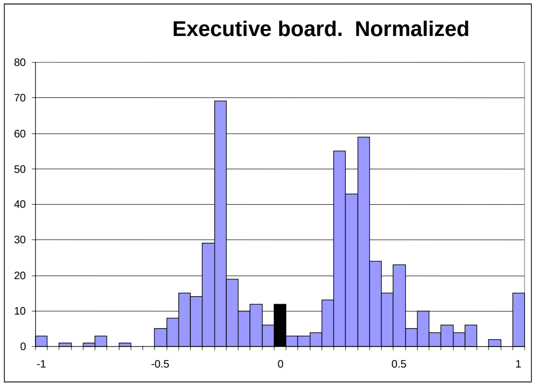
ELECTION: David 1015; Yihe 809; Abs 233


Academic Affairs

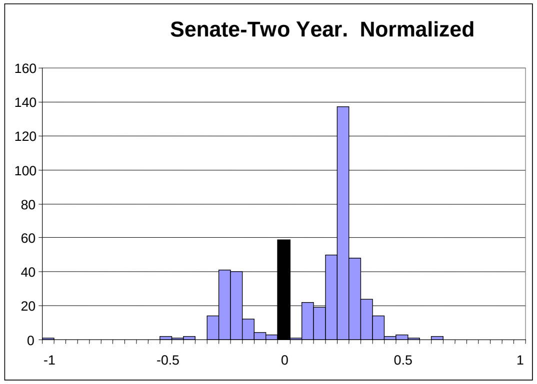
Alidad >0
Outcome: Alidad 230; Ehizoje 195; Abs. 77
Bonus Votes: Alidad 30 ; Ehizoje 38
Intensity: Alidad 1132; Ehizoje 1181

ELECTION: Alidad 1060; Ehizoje 634; Abs 363

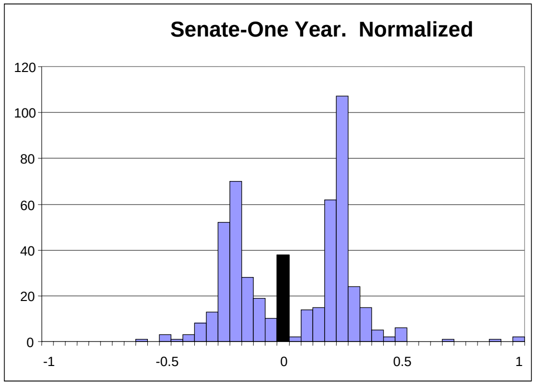
COLUMBIA COLLEGE - NORMALIZED



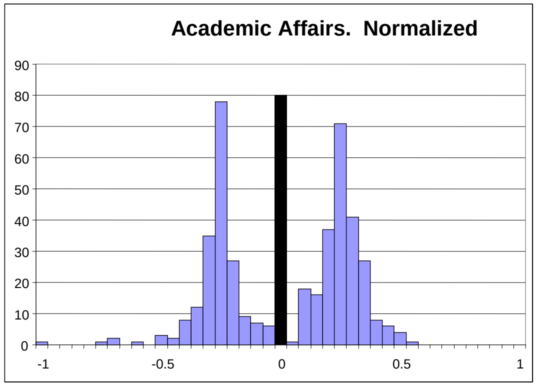
Open Columbia >0
Outcome: Open Columbia 294; Evolution 199; Abs 9
Bonus Votes: Open Columbia 205; Evolution 105
Intensity: Open Columbia 114; Evolution 61



Tiffany >0
Outcome: Tiffany 324; Gerry 12; Abs 58
Bonus Votes: Tiffany 48; Gerry 9
Intensity: Tiffany 76; Gerry 30



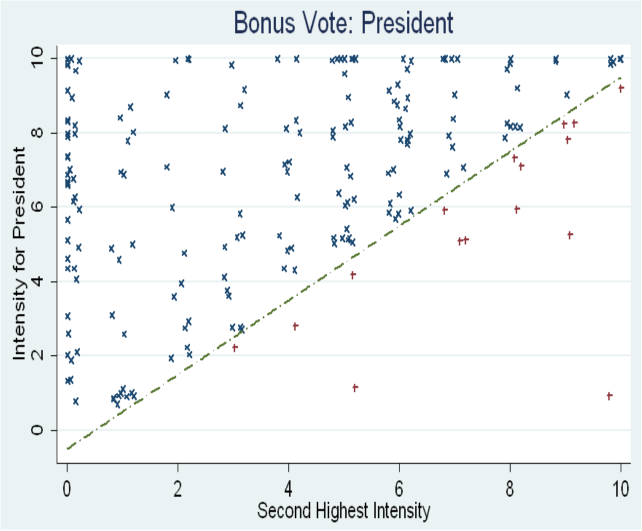
David >0
Outcome: David 256; Yihe 208; Abs 38
Bonus Votes: David 29; Yihe 29
Intensity: David 61; Yihe 48



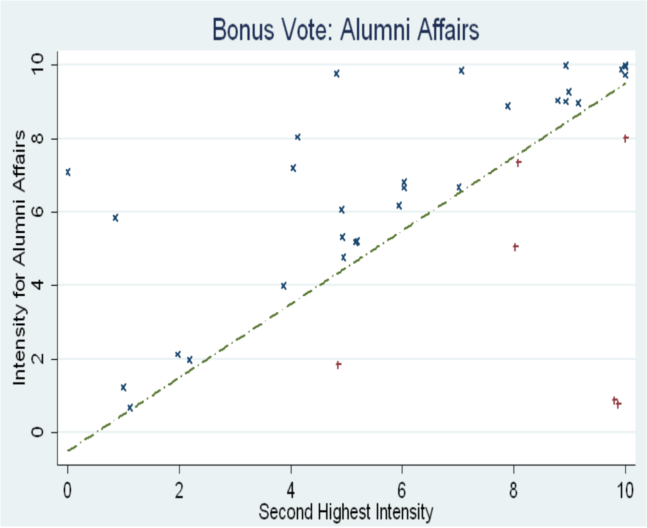
Alidad >0
Outcome: Alidad 230;Ehizoje 195; Abs 77
Bonus Votes: Alidad 30; Ehizoje 38
Intensity: Alidad 55; Ehizoje 55

FIGURE 3
IS THE BONUS VOTE CAST ON THE HIGHEST VALUATION?

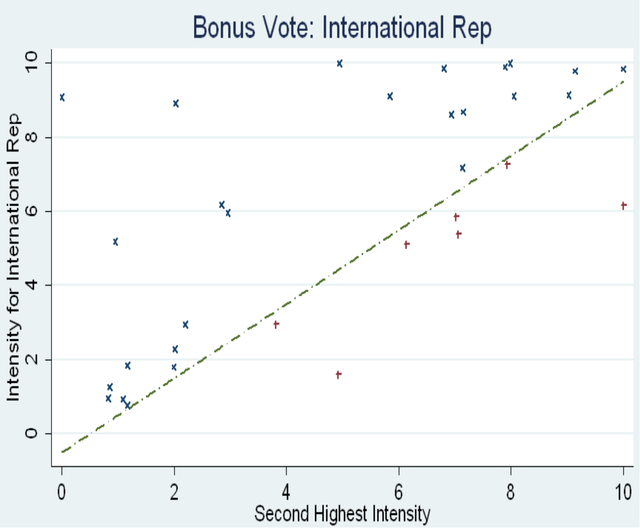
Figure 3a: General Studies



Most salient

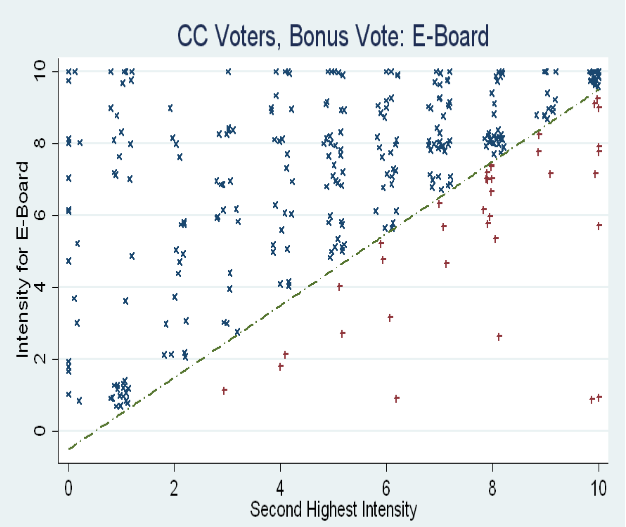


Lowest margin of victory

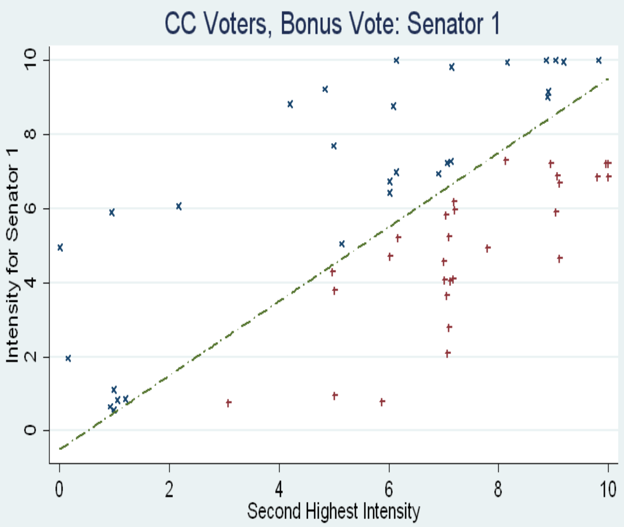


Highest margin of victory

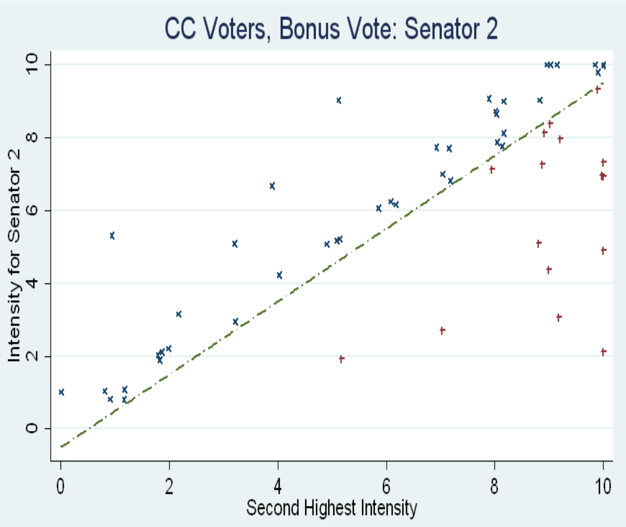
Figure 3b:Columbia College



Most salient



Lowest margin of victory



Highest margin of victory

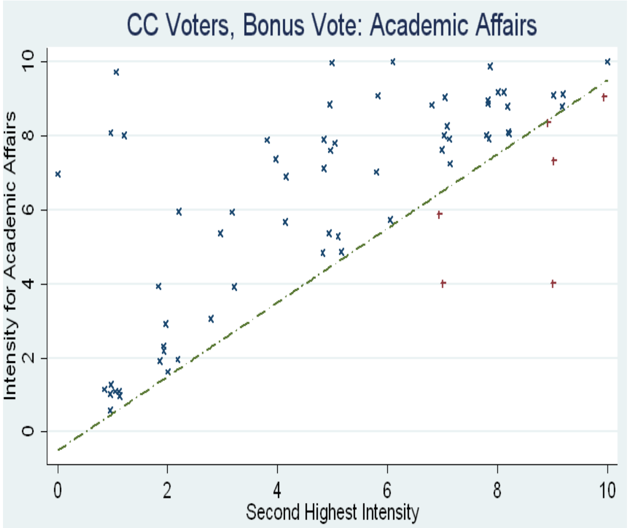


FIGURE 4
FREQUENCY OF CHANGED OUTCOMES
10,000 bootstrap samples

Figure 4a: General Studies

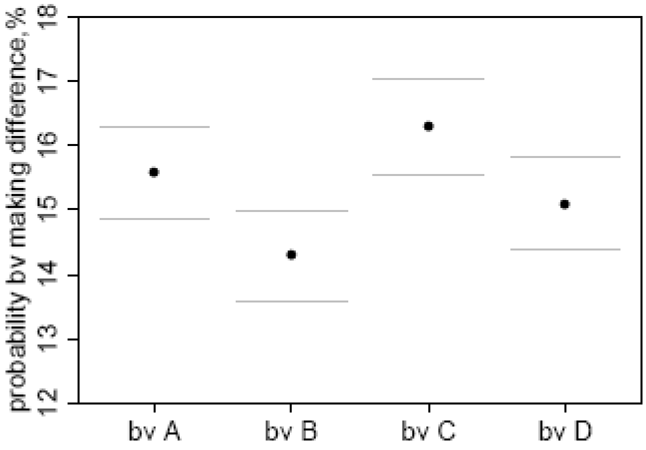
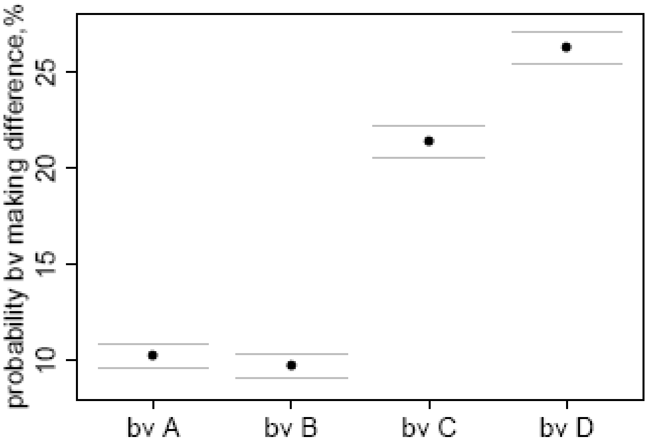


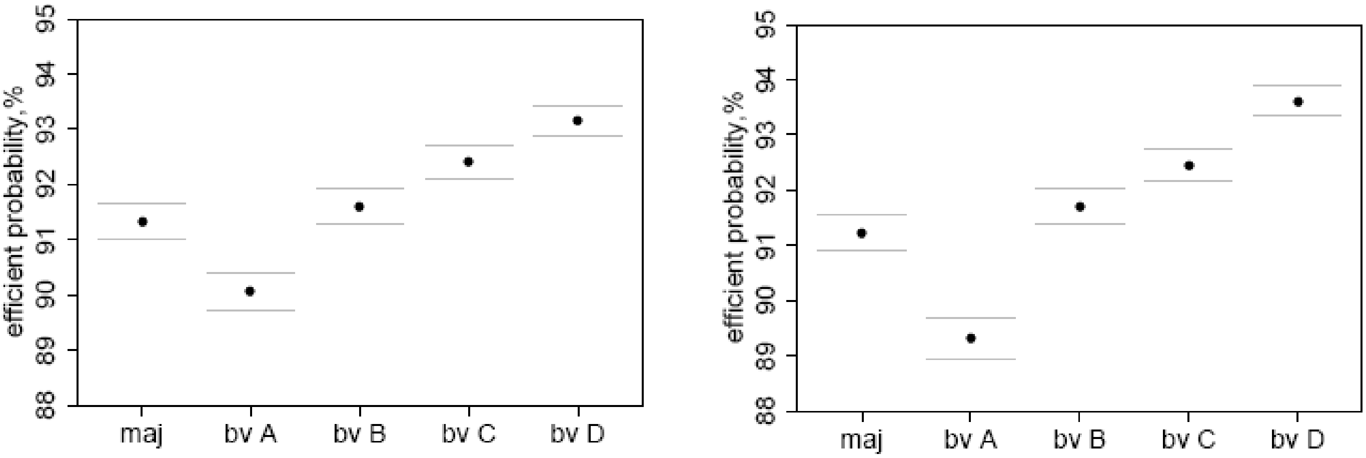
Figure 4b: Columbia College



The grey lines are +/- 2 standard errors.

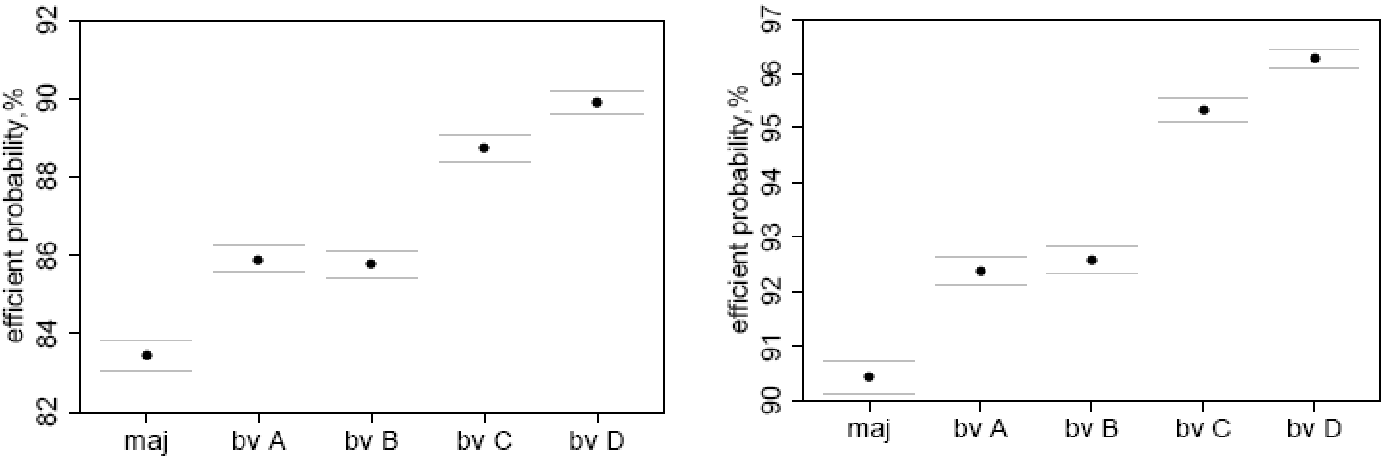
FIGURE 5
FREQUENCY OF EFFICIENT OUTCOMES
10,000 bootstrap samples

Figure 5a: General Studies



Raw intensity **Standardized intensity**

Figure 5b: Columbia College



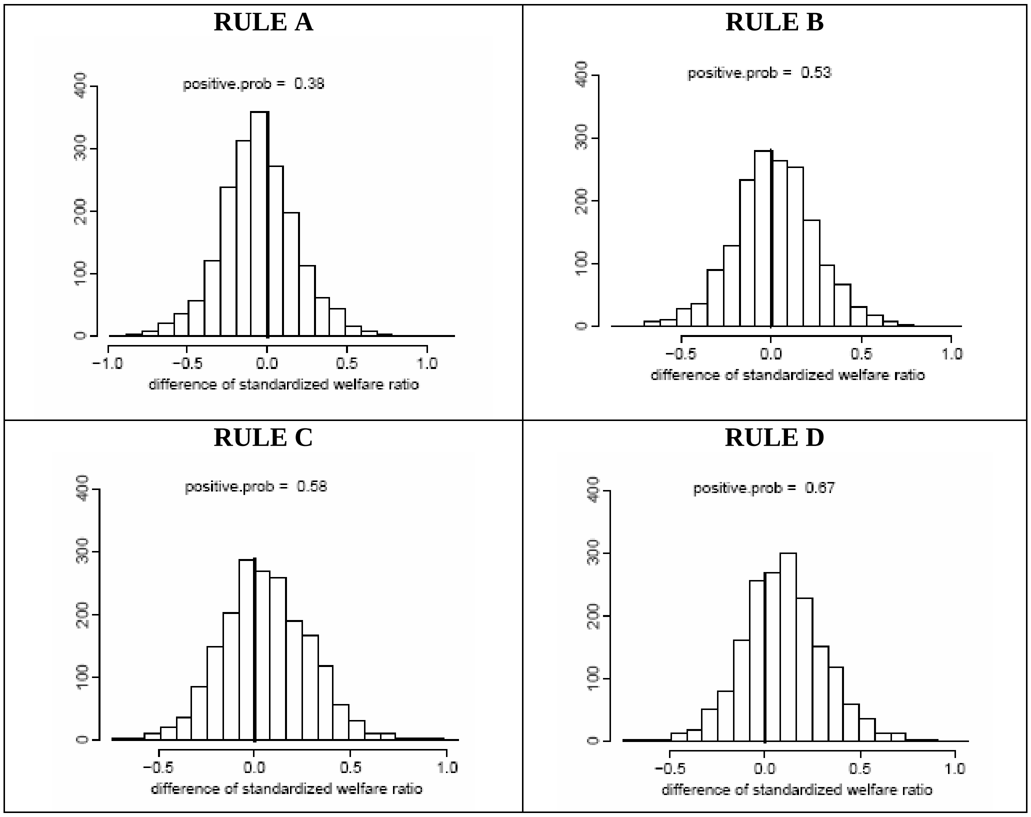
Raw intensity **Standardized intensity**

The grey lines are at +/- 2 standard errors

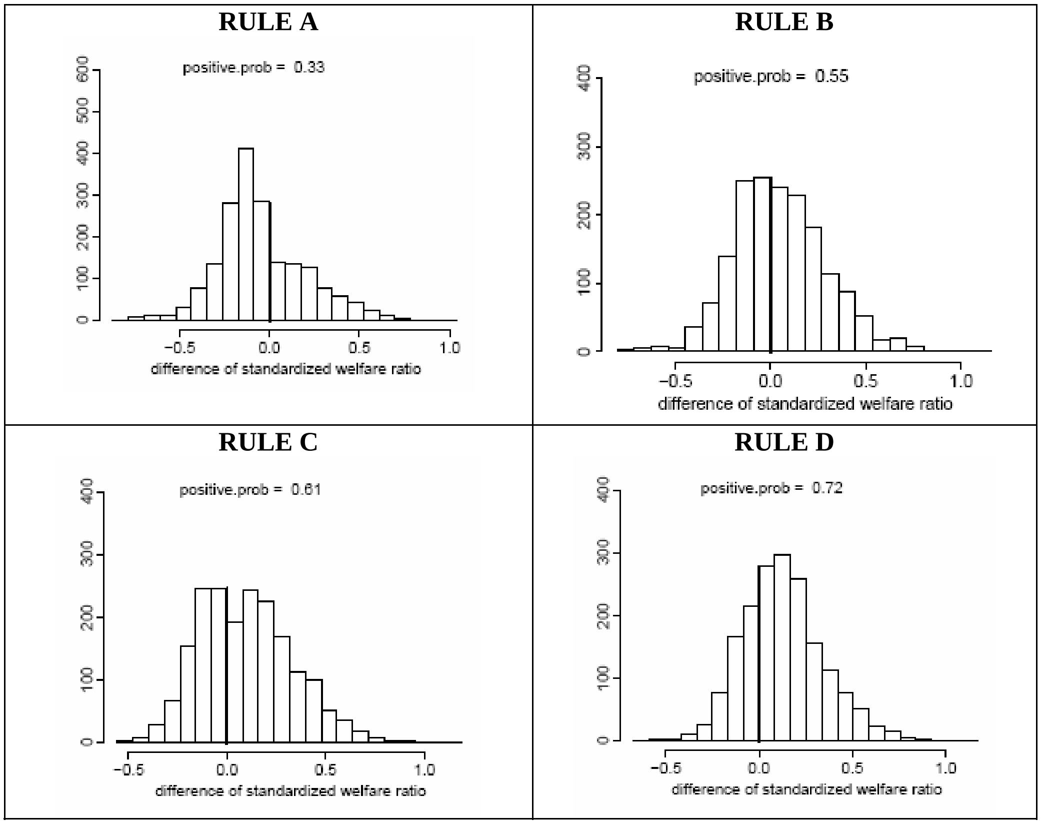
FIGURE 7
WELFARE CHANGE OVER MAJORITY VOTING, WHEN OUTCOMES DIFFER

Figure 7a: General Studies

Raw Valuations



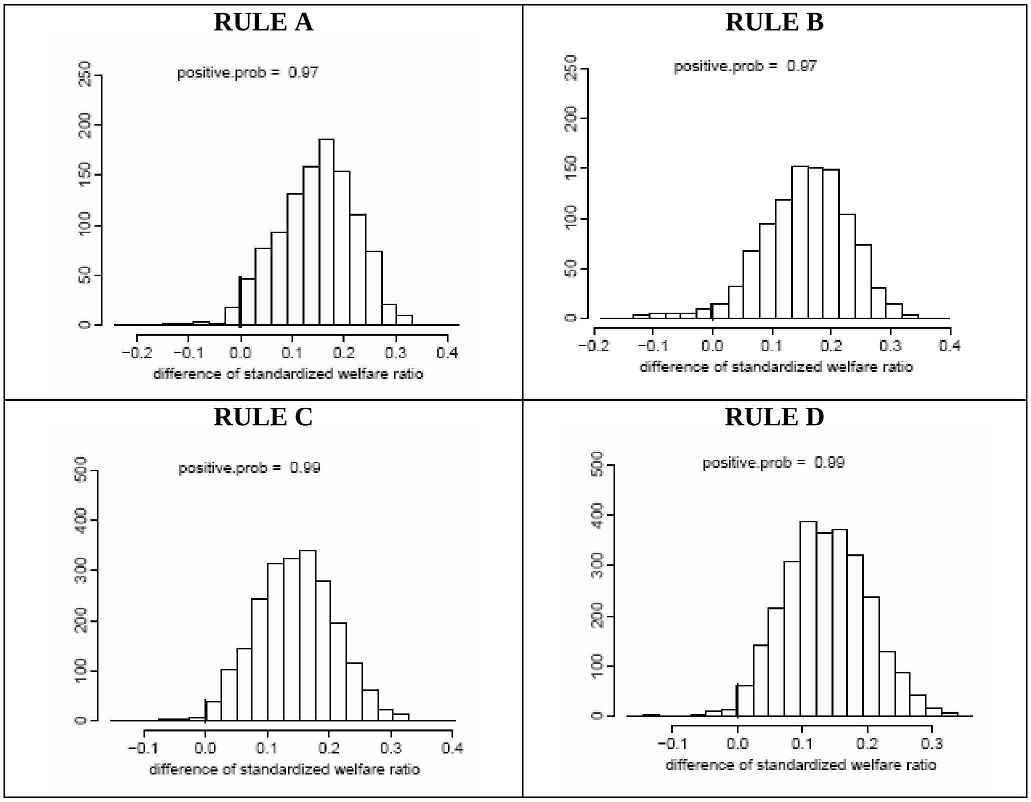
Normalized Valuations



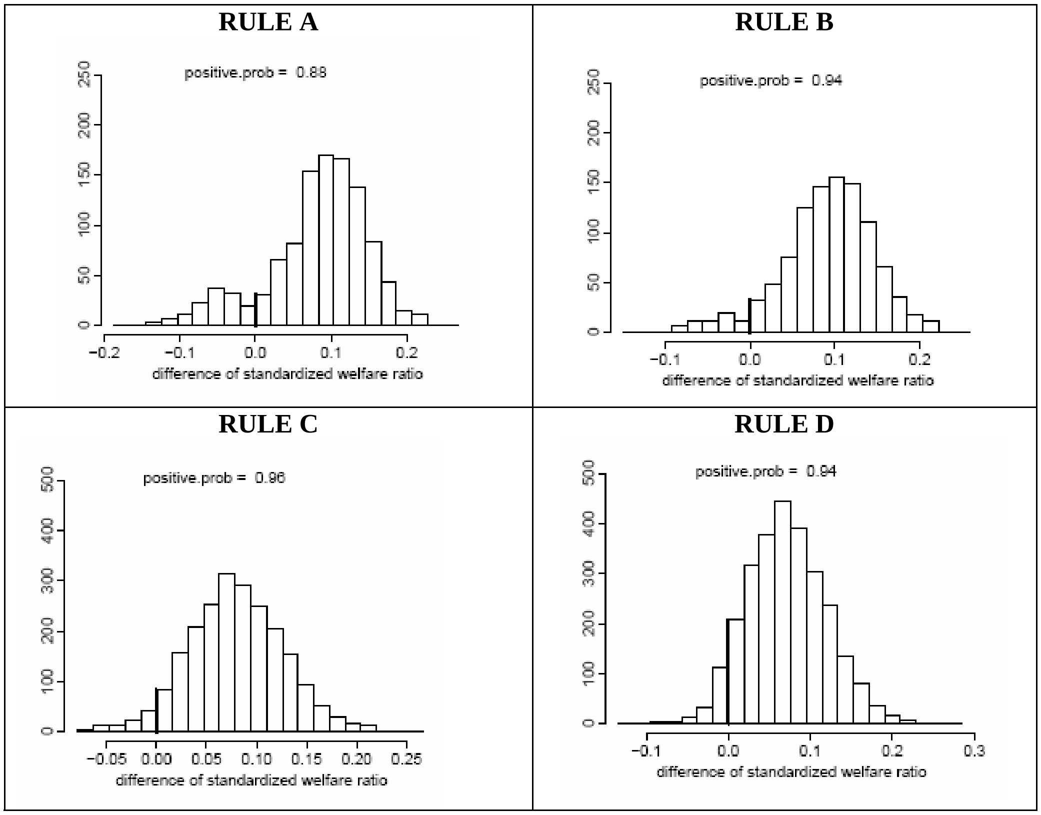
WELFARE CHANGE OVER MAJORITY VOTING, WHEN OUTCOMES DIFFER

Figure 7b: Columbia College

Raw Valuations



Normalized Valuations



Columbia University Economics Department **Voting Experiment**

Thank you for choosing to participate in this experiment. By entering your number below, and attaching your post-it to the questionnaire you acknowledge that you have read, and understand the consent form (attached to the ballot box). Please enter your number here:

____

A lottery will be conducted among all participants who have followed the instructions of the experiment and written the number above legibly. The winner will receive an iPod.

This experiment asks you how much you care about the outcome of some of the elections.

Each election can be scored on a scale of 1-10, with 10 meaning "care very much" and 1 meaning "care not at all". In order to indicate a box, please cross out the relevant number with an X like this:

☒ 9

E-Board

1	2	3	4	5	6	7	8	9	10

Senate (1 year)

1	2	3	4	5	6	7	8	9	10

Senate (2 year)

1	2	3	4	5	6	7	8	9	10

Academic Affairs

1	2	3	4	5	6	7	8	9	10

Suppose now that, in addition to the regular votes you cast earlier, you had 1 additional vote to cast in favor of your candidate in one of the elections. You can choose any of these four elections as you see fit. Which one would you choose? (NOTE: This is for experimental purposes only. Your answer will **not** change the outcome of the actual elections in any way).

Please check the box under the election you choose. Please check **only one** box.

E-Board	**Senate (1 year)**	**Senate (2 year)**	**Academic Affairs**
Evolution	David Ali	Tiffany Davis	Ehizoje Azeke
Open Columbia	Yihe (Eric) Wang	Gerry Rodriguez	Alidad Damooei
☐	☐	☐	☐

Thank you for participating. And good luck with the lottery!