Voting for Compromises: Alternative Voting Methods in Polarized Societies*

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Abstract

Democratic societies have been increasingly confronted with extreme, knife-edge election outcomes that affect everybody's lives and contribute to social instability. Even if political compromises based on social conventions as equity or economic arguments as efficiency are available, polarized societies might fail to select them. We demonstrate that part of the problem might be purely technical and, hence, potentially solvable. We study different voting methods in three experiments (total $N = 5,820$), including small, medium-sized, and large electorates, and find that currently-used methods (Plurality Voting and Rank-Order systems) can lead to widespread selection of egoistic options. In contrast, alternative, more nuanced methods (Approval Voting and Borda Count) favor equity and efficiency, avoiding extreme outcomes. Those two methods differ in their support of equity vs. efficiency when the latter benefits a majority. Our evidence suggests that targeted changes in the electoral system could favor socially-desirable compromises and increase social stability.

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1 Introduction

The recent years have seen a rise of extremism and polarization in many democratic societies, be it in terms of the views of individual voters, the strength of partisanship, the distance between candidate platforms, or the extremism in pursued policies (Abramowitz and Saunders, 2008; Sunstein, 2009; Iyengar and Westwood, 2015; Mason, 2015; Boxell et al., 2017; Martini and Torcal, 2019). Many voters currently view the political process as confrontational (us vs. them) instead of conceiving of it as the search for political solutions with the potential to benefit a wide majority, and this tendency has been argued to threaten basic democratic principles (Graham and Svolik, 2020). The consequences can range from social and political instability and knife-edge, seemingly-random election outcomes to governments implementing heavily-partisan agendas.[1]

Extreme political outcomes in the absence of clear majorities are particularly problematic if electorates fail to identify alternatives which could serve as compromises and gain widespread social support. However, there is reason to believe that such compromises might often be within reach. A number of well-established social conventions and principles have been shown to enjoy generalized support, even in polarized societies, and to be important determinants of actual voter behavior (e.g., Feddersen et al., 2009; Shayo and Harel, 2012; Fisman et al., 2017; Morton and Ou, 2019). Alternatives appealing to such well-established social conventions could often help identify acceptable compromises and build a wide consensus. Key among them is *equity* (equal treatment of individuals), which underlies many prominent sociopolitical ideas, from distributive justice to equality of opportunities. For instance, the recent rise of nationalist parties centered on specific regions of European countries could be argued to reflect a concentration on self-interest as opposed to equity. Another powerful idea is *efficiency* (maximization of joint payoffs), which motivates many uncontroversial economic arguments from waste avoidance to cost-benefit analysis. For instance, the rise of centrifugal political forces in Europe could be conceived as the result of a contest between the overall economic gains of remaining in a large trade union and the self-centered concerns arising from, e.g., local job insecurity due to international reallocation of production factors.

Ideally, the electoral process should help identify such broadly-supported compromises, and, going one step back, facilitate their appearance in the political arena. This, however, does not seem to be the case. Social conventions and appealing political and economic principles do not always succeed in providing "moral roots" (see, e.g., Haidt, 2008) and facilitating compromising on moderate alternatives. From the point of view of political economy and social choice theory, this failure might not be surprising. Since, as shown in influential results as Arrow's Impossibility Theorem (Arrow, 1963) or the Gibbard-Satterthwaite Theorem (Gibbard, 1973; Satterthwaite, 1975), every voting method violates at least one of a number of reasonable properties, there is no ideal voting

[1] Further, when political outcomes fail to enjoy widespread support, the recognition of the legitimacy of the electoral system, especially among losers, might suffer, further detracting from the stability of governments or resolutions (losers' consent; Nadeau and Blais, 1993; Anderson and Mendes, 2006).

method and a wide variety of procedures could be used. It is well-known that different voting methods can elicit different results from the same electorate (e.g. Riker, 1982; Saari, 1994, 1999; Granić, 2017), and hence it is *a priori* not surprising that some voting methods might not be well-suited to identify compromises.[2]

Many commonly-used voting methods in actual political elections are based on *Plurality Voting* (PV). Under this method, voters are asked to report only their most-preferred alternative, i.e., the maximum of their respective preferences. But the theoretical argument showing that PV will in general fail to identify compromises is both straightforward and transparent. By eliciting only the maximum, the method disregards all other information contained in the preferences. A compromise alternative will very frequently be ranked high by a wide majority, but not necessarily at the very top. If three extreme alternatives are ranked highest by a third of the electorate each, but the entire electorate would rank a fourth, moderate alternative second, under PV this fourth alternative (which is clearly a compromise) will receive no support.

In this work, we compare the performance of PV and two alternative voting methods in terms of the selection of compromises. We carried out a number of experiments where actual human participants made voting decisions (Forsythe et al., 1993, 1996; Hix et al., 2017) in up to four different, artificially-designed societies following the three different voting methods. Our data further allows to analyze the outcomes under two additional methods. In our "small electorates" laboratory experiment, each voter participated in multiple elections in four different experimental societies with six voters each. We collected 5,400 voting decisions, systematically varying the voting method for each society. To ensure external validity, we also carried out two large-scale online experiments, one with "medium electorates" of 30 voters each (and a total of 19,440 additional voting decisions) and another with two "large electorates" of 1,200 voters each, which replicated the results obtained for small electorates.

The two alternative methods that we included in our experiments were selected due to their potential to identify compromises. One is the Borda Count (BC), which asks voters to provide entire rankings by assigning points to each alternative, with zero being allocated to their least-preferred option, one to the second-least preferred, and so on, until $n-1$ points are assigned to the most-preferred one, with n being the number of available alternatives. The winner is the alternative with the most points, with ties broken randomly. The theoretical properties of this method have been extensively studied (e.g., Saari, 1999, 2000, 1994). For instance, the method has been argued to minimize the number of voting paradoxes in a well-defined sense, among all positional methods (those based on point allocations). The argument for compromises, though, is again straightforward. Widely-supported compromises should generally reach a high point total and have a reasonable chance of offsetting the support. However, this assumes sincere voting behavior. Regrettably, BC is transparently manipulable in the sense of

[2]The electoral system also affects satisfaction with and acceptance of democratic outcomes (Anderson and Guillory, 1997).

the Gibbard-Satterthwaite theorem: if an option is seen as a threat to the own top alternative, falsely ranking the former last increases the chances of the favorite alternative winning. Thus, it is unclear whether BC will actually select compromises in multi-alternative elections.

Another alternative method which might be well-suited to identify compromises is Approval Voting (AV), which allows each voter to vote for (or "approve of") as many alternatives as wished (Brams and Fishburn, 1978). The intention is that voters reveal which alternatives are acceptable, and the alternative with the highest number of approvals wins the election (with ties broken randomly). The properties of this method have been studied both theoretically and empirically.[3] Contrary to BC, AV has been shown to eliminate incentives to vote strategically (Brams and Fishburn, 1978; Alós-Ferrer and Buckenmaier, 2019). For instance, under PV voters might be tempted by "wasted vote" arguments not to vote for their most-preferred alternative if it is believed to have low chances of winning, while under AV there is no reason not to approve of it (possibly together with other alternatives).[4]

In our societies, voters were endowed with (monetarily-induced) preferences and the alternatives pitted Self-Interest options, which favored specific groups, against social conventions based on Equity and Efficiency, either separately or jointly. By varying the consequences of Efficiency for different groups, we also varied the consequences of inequality and, in particular, whether Efficiency favored a majority or just a minority. Our societies were polarized in the sense that the opposed groups were equally-sized, and none of them was close to achieving a majority. To study the effect of the relative size of the competing interest groups within an electorate, the medium electorates experiment included an additional asymmetric treatment, which extends our results to interest groups of different sizes. Additionally, the laboratory experiment included a preference elicitation task after the voting decisions. We study two additional, rank-order voting procedures (Single Transferable Vote and the Two-Round System) using extrapolation based on those elicited preferences (following, e.g., Felsenthal et al., 1993; Felsenthal and Machover, 1995).

The results are striking. Our evidence shows that currently-favored voting methods, based on the "one man, one vote" principle (Plurality Voting), exacerbate self-centered voter behavior and result in outcomes favoring a particular group. Under rank-order voting methods (as those used in several countries for parliamentary elections, e.g. in Australia), results are even more extreme. In contrast, methods which allow voters to support several options (Approval Voting) or to provide entire rankings (Borda Count) favor social compromise in the form of either equity or efficiency. Thus, we demonstrate that extreme political results might reflect not only voter preferences, but also the voting method. We illustrate how giving voters *more* possibilities to express their preferences

[3] Approval voting is used for municipal elections in the US in Fargo, North Dakota since 2018, and St. Louis, Missouri since 2020. It is also used various associations, including the U.S. National Academy of Sciences, and by the United Nations to elect the Secretary-General.

[4] See Fishburn (1978, 1979), Alós-Ferrer (2006), and Xu (2010) for axiomatizations of Approval Voting.

can reduce both self-centered voting decisions and extreme outcomes even when voter preferences are kept constant. Thus, at the risk of being provocative, our evidence suggests that part of the problem underlying extreme political outcomes might be purely technical and, hence, potentially solvable.

In detail, our empirical findings are that Plurality Voting and Rank-Order methods create situations where options that favor just a minority win the upper hand in elections very frequently, while Approval Voting and Borda Count successfully gather support around socially desirable compromises. Borda Count systematically favors Equity-based alternatives, while Approval Voting favors Efficiency when inequality is not a concern (meaning that Efficiency favors a majority), but turns toward Equity when inequality is a problem (meaning that Efficiency favors only a minority). The changes in electoral outcomes across methods are large and occur in spite of the fact that the electorate's preferences are kept constant. That is, the changes occur simply by virtue of the voting method. This is important because the social roots and causes of polarization are complex and difficult to address (voters' preferences, affective issues, etc.), but changing the voting method, within the parameters given by a democratic society, amounts to a legislative decision, and is hence a feasible first step.

We also analyze sincerity in individual voting behavior, and find evidence for a large fraction of strategic votes in all our experiments. Electoral outcomes often differ from those predicted under sincere voting, but the overall result is that Equity and Efficiency are selected *more* often than sincere voting would predict. In the Appendix, we also discuss the consequences for winner's legitimacy, and provide additional analyses and details.

2 Related Literature

Previous empirical evidence has already shown that the results of PV can be improved upon by using alternative voting methods. For example, using data from UK elections in various trade unions, professional associations and non-profit organizations Felsenthal et al. (1993) and Felsenthal and Machover (1995) found that the outcomes of Plurality Voting procedures, where each voter must select one candidate only, were inferior, in terms of several normative criteria, to the outcomes that would have obtained under alternative methods, including BC and AV. A number of field experiments carried out during actual political elections have shown that alternative voting methods, especially AV, would have resulted in different outcomes, e.g. in presidential elections in France (Laslier and Van der Straeten, 2008; Baujard et al., 2014) and in federal and state elections in Germany (Alós-Ferrer and Granić, 2012, 2015). Other empirical studies have shown differences across voting methods in small-electorate elections carried out in the lab (Laslier, 2010; Bassi, 2015; Granić, 2017). However, little is known so far about the relation between specific methods and the distributional properties of the outcomes that they favor, and even less is known about the interaction between voting methods

and morally-rooted social conventions. Consequently, it is important to ask whether and how the voting method itself affects the results in terms of distributional allocations and whether or not different methods might facilitate the selection of compromises.

A related stream of literature has studied the effect of aggregate uncertainty about the distribution of preferences on voter behavior, election outcomes, and social welfare. Bouton et al. (2017) show that under PV aggregate uncertainty increases sincere voting and allows for non-Duverger's Law equilibria, which, however, increases the occurrence of costly coordination failures. Bouton et al. (2016) compare the welfare properties and the degree of strategic voting between PV and AV in a common value setting with aggregate uncertainty and find substantial welfare gains under AV. Bouton et al. (2022) find that under aggregate uncertainty voters are less strategic in run-off systems than under PV in some situations. However, these small differences in voting behavior do not result in differences in electoral outcomes or voters' welfare. In contrast, in our setting voters have private values and perfect information about the distribution of preferences in the electorate.

Our work contributes to the literature which examines the consequences of social conventions for electoral outcomes. The basic model of rational voting (Downs, 1957) assumes self-centered motivations, where voters maximize their own payoffs and act strategically. Strategic voting has indeed been shown to be empirically relevant (e.g., Black, 1978; Fisher, 2004) and to vary with voter characteristics (Eggers and Vivyan, 2020). However, both equity and efficiency have been empirically demonstrated to be key determinants of actual human behavior for distributive decisions (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Bechtel et al., 2018) and actual voting behavior (Feddersen et al., 2009; Shayo and Harel, 2012; Morton and Ou, 2019). Linking individual equity-efficiency trade-offs to political decisions during the 2012 US elections, Fisman et al. (2017) found that the majority of equality-focused subjects did vote for Barack Obama (and were democrats), indicating that distributional preferences are a strong motive underlying voting behavior. In a different context, distributional concerns related to social conventions (as opposed to self-interest) have been shown to be important for political participation (voter turnout; see, e.g., Feddersen and Sandroni, 2006; Fowler, 2006; Fowler and Kam, 2007; Gerber et al., 2008; Gerber and Rogers, 2009). Given their empirical relevance for individual behavior, social conventions should have been expected to play a crucial role to hinder extreme outcomes and identify socially-desirable compromises. Yet, under current electoral systems, there appears to be little evidence of such a moderating effect at this point.

Some previous works have studied equity-efficiency trade-offs, but have typically concentrated on a single voting method only. For instance, in a majority-rule voting game, Bolton and Ockenfels (2006) found twice as many deviations from self-interest in favor of equity than in favor of efficiency. In contrast, we focus on the interaction between voting methods and social conventions.

A plethora of voting methods are in use around the world, differing across dimensions such as how voters express their wishes and how votes are converted into representation. Accordingly, a strand of the literature has studied and compared different voting mechanisms, but not with respect to outcome selection and the equity-efficiency trade-off. Instead, such studies have focused, e.g., on informational efficiency and unequal cost of voting (strategic abstention) under simultaneous and sequential voting procedures (Battaglini et al., 2007), or on the comparison of sincerity and strategic behavior across methods (Bassi, 2015). The contribution of our work is to analyze the relative importance of different social conventions on voting behavior across voting methods and, in particular, whether (and if so, for which methods) they can promote socially-desirable compromises.

3 Experimental Design

In all experiments, subjects were matched into electorates which remained fixed for the duration of the experiment. Each subject participated in a series of elections, each in a different voting round. Voting rounds were independent, that is, subjects received no feedback on the election outcomes or on the decisions of other voters. At the end of each experiment for each electorate one of the voting rounds was selected at random and subjects were paid according to the outcome of this round. All payoffs were presented in terms of Experimental Currency Units (ECU) that were converted to the appropriate currency at the end of the experiment at a fixed rate.

For each election, preferences over outcomes were induced by conditioning subjects' payoffs on the election outcomes. There were three types of voters, each with a different monetary reward associated to each of the alternatives. The complete payoff profile of the electorate was presented on screen in the form of a table. That is, the induced preferences of all voters within an electorate were publicly known to all voters. We used four qualitatively different payoff profiles, corresponding to four experimental societies, with either four or five alternatives.[5] Elections used three different voting methods: Plurality Voting (PV), Approval Voting (AV), and the Borda Count (BC). Under PV, voters had to vote for exactly one of the alternatives. Under AV, voters could approve of as many alternatives as they preferred, but had to approve of at least one alternative (abstention in the sense of casting the full ballot was allowed). Under BC, voters had to rank all alternatives by assigning 0 points to their least-preferred alternative, 1 point to their second-least-preferred alternative and so on with the highest number of points being assigned to the most-preferred alternative. The winner is the alternative that received most votes, approvals, or points in total within an electorate, respectively. For all voting methods ties were broken randomly.

[5]Standard voting experiments typically use a fixed number of alternatives between three and five (see e.g. Forsythe et al., 1993, 1996; Blais et al., 2016; Hix et al., 2017).

3.1 Experimental Societies and Predictions Under Sincere Voting

Table 1 summarizes the payoff profiles and induced preferences in our four experimental societies, assuming an equal number of voters for each type (this was true for most of our experiments). The table also displays the predicted winners under the assumption that voters sincerely report their induced preferences. Appendix F reports the (straightforward) computations in more detail.

Society 1

Type	1	2	3	
#	n	n	n	
SI_1	95	55	45	$195n$
SI_2	45	95	55	$195n$
SI_3	55	45	95	$195n$
Equ	65	65	65	$195n$
Induced Preferences	SI_1	SI_2	SI_3	↑
	Equ	Equ	Equ	
	SI_3	SI_1	SI_2	
	SI_2	SI_3	SI_1	
Predictions (Sincere)	PV	SI_1 / SI_2 / SI_3		
	BC	Equ		
	AV_2	Equ		
	AV_3	Equ		

Society 2

Type	1	2	3	
#	n	n	n	
SI_1	95	55	45	$195n$
SI_2	45	95	55	$195n$
SI_3	55	45	95	$195n$
Eff	90	80	40	$210n$
Induced Preferences	SI_1	SI_2	SI_3	↑
	Eff	Eff	SI_2	
	SI_3	SI_1	SI_1	
	SI_2	SI_3	Eff	
Predictions (Sincere)	PV	SI_1 / SI_2 / SI_3		
	BC	SI_1 / SI_2		
	AV_2	Eff / SI_2		
	AV_3	SI_1		

Society 3

Type	1	2	3	
#	n	n	n	
SI_1	95	55	45	$195n$
SI_2	45	95	55	$195n$
SI_3	55	45	95	$195n$
Equ	65	65	65	$195n$
Eff	90	80	40	$210n$
Induced Preferences	SI_1	SI_2	SI_3	↑
	Eff	Eff	Equ	
	Equ	Equ	SI_2	
	SI_3	SI_1	SI_1	
	SI_2	SI_3	Eff	
Predictions (Sincere)	PV	SI_1 / SI_2 / SI_3		
	BC	Equ		
	AV_2	Eff		
	AV_3	Equ		

Society 4

Type	1	2	3	
#	n	n	n	
SI_1	95	55	45	$195n$
SI_2	45	95	55	$195n$
SI_3	55	45	95	$195n$
Equ	65	65	65	$195n$
Eff	62	58	90	$210n$
Induced Preferences	SI_1	SI_2	SI_3	↑
	Eff	Equ	Equ	
	Equ	Eff	Eff	
	SI_3	SI_1	SI_2	
	SI_2	SI_3	SI_1	
Predictions (Sincere)	PV	SI_1 / SI_2 / SI_3		
	BC	Equ		
	AV_2	Equ		
	AV_3	Equ / Eff		

Table 1: Societies 1–4. Payoff profiles, induced preferences, and predicted outcomes under sincere voting.

Note: Outcomes are calculated under the assumption that subjects vote sincerely according to their induced preferences. AV_2 assumes that all voters approve of exactly two alternatives. AV_3 assumes that all voters approve of exactly three alternatives.

In all four societies, three of the alternatives correspond to *Self-Interest* options giving maximal payoff to a single voter type at the expense of others in society. These options were labeled neutrally in the experiment but depicted as SI_1, SI_2, and SI_3 in our tables. For PV, under sincere voting the predicted electoral outcomes are triple ties among

the Self-Interest options, with no support for other available alternatives. In practice, in a noisy, real-life environment, under sincere voting we would expect the winner to overwhelmingly correspond to one of these options.

Society 1 includes an *Equity* option, denoted Equ in our tables, which equalizes cardinal payoffs and is ranked second by all voters. Self-Interest alternatives and Equity paid the same total amount to the electorate; hence, there was no difference in terms of efficiency when comparing Self-Interest to Equity. Society 2 includes an *Efficiency* option instead, denoted Eff in our tables. This option results in a larger sum of payoffs than any other option but creates inequality, with two thirds of the electorate being *Efficiency Winners* (EWs) and ranking this option second, and the remaining third being *Efficiency Losers* (ELs) and ranking this option last. This profile was also designed to minimize the effect of equity concerns, with no clear equity-based focal point according to standard theories (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000). Societies 3 and 4 include both Equity and Efficiency options. Equity is hence ranked third for EWs (after Efficiency) and second for ELs. In Society 3, Efficiency again favors a majority of the electorate, while in Society 4 it favors a minority.

The prediction of BC under sincere voting is straightforward: Equity, which is ranked second or third by all voters, always wins if available. In Society 3, where an Equity option does not exist, BC predicts the Self-Interest options of the EWs.

AV does not deliver a point prediction, since it is unclear how many options a given voter should approve of (this is a main criticism of AV). Hence, strictly speaking it is not possible to compare the results to a normative benchmark. However, previous field experiments suggest that most people tend to approve of one, two, or three alternatives (e.g., Alós-Ferrer and Granić, 2012; this was also the case in our experiments, see Table A.2 in the Appendix). Hence, Table 1 displays the predicted results under sincere voting and the additional assumption that all voters approve of two options (AV_2) or all voters approve of three options (AV_3). For Society 1, Equity is predicted to win in both cases. For Society 2, AV_2 predicts a tie between Efficiency and SI_2, and AV_3 predicts SI_1 as the unique winner. For Society 3, AV_2 predicts Efficiency and AV_3 predicts Equity. For Society 4, AV_2 predicts Equity and AV_3 predicts a tie between Equity and Efficiency. Overall, the picture is that AV under sincere voting might tend to favor compromises, but (unsurprisingly for this method, where predictions are rarely well-defined) it is unclear which.

There are, however, two reasons why the predictions under sincere voting might not hold empirically. First, it is well known that actual voters might vote strategically, misrepresenting their preferences. Theoretical results have shown that any voting method within a wide family creates incentives to misrepresent preferences for strategic reasons (Gibbard, 1973; Satterthwaite, 1975), and empirical evidence suggests that strategic voting is frequent in political elections (e.g., Black, 1978; Alvarez and Nagler, 2000; Fisher, 2004; Eggers and Vivyan, 2020). For instance, strategic considerations lead to the wasted-vote effect where favorite candidates thought to be unlikely to win

are abandoned in favor of popular ones, which might ultimately lead to a reduction in the number of parties (Duverger, 1954). The argument is less strong for AV, which in principle provides no incentives for strategic voting (Brams and Fishburn, 1978; Alós-Ferrer and Buckenmaier, 2019). However, the predictions under sincerity for AV are less clear by the very nature of the method. Section 5 analyzes actual deviations from sincere voting at the individual level.

Second, even if voters did cast their votes sincerely, the very nature of our argument is that compromise alternatives appeal to voters at a fundamental level, and in particular the monetarily-induced preferences might not be their true preferences. As discussed above, models of social preferences argue precisely that equity and efficiency are intrinsically preferred by at least some decision makers (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002), and empirical work has shown that actual voting behavior is influenced by these dimensions (Feddersen et al., 2009; Shayo and Harel, 2012; Morton and Ou, 2019). For this reason, the laboratory experiment included a preference elicitation task after the voting decisions, which allows us to examine revealed preferences. Section 5 also analyzes sincerity with respect to these *elicited* preferences.

3.2 Procedures: Small Electorates

The Small Electorates (SE) experiment was conducted at the Cologne Laboratory for Economic Research (CLER) using ORSEE (Greiner, 2015) for recruitment and z-Tree (Fischbacher, 2007) for the experiment. The experiment consisted of six sessions with a total of 180 subjects (111 female) who made a total of $5,400$ voting decisions. Subjects were randomly assigned to 30 different small electorates consisting of six subjects each, two for each type. Each subject took part in 40 elections split into four blocks of 10 independent elections each. Each block used a different voting method, which was fixed for all elections in the block. The three main (within-subject) treatments are PV, AV, and BC, which were used in the first three blocks.[6] In the final block all electorates voted via a random dictator mechanism used for preference elicitation (see Secion 5 for details).

In Society 1 there were four alternatives available and the payoff profile was symmetric across types, that is, the monetary rewards for each type were identical up to a relabeling of the alternatives. Subjects were randomly assigned a type and cast one vote for Society 1 in that role. In contrast, Societies 2 to 4 were not symmetric, that is, the induced preferences over alternatives were qualitatively different across types. There were three rounds of elections for each of those profiles so that each subject cast exactly

[6]Their order was randomized across electorates within a session to eliminate any potential order effects. At the beginning of each block subjects received a detailed description of the voting method on screen.

one vote in each role.[7] In each block the so-obtained 10 payoff profiles were presented in a pseudo-randomized order that was the same for each block, which allows for a clean comparison of voter behavior for a given profile (and type) across voting methods.

The exchange rate for payoffs was 0.20 EUR for 1 ECU (equivalent to $0.235 at the time of the experiment). Sessions took on average 70 minutes and subjects received an average payoff of 13.46 EUR plus an additional show-up fee of 4 EUR.

3.3 Procedures: Large Electorates

The laboratory experiment concentrated on small electorates. In actual political elections, electorates are large and individual decisions are almost negligible. Also, experimental evidence has shown that ethically-motivated alternatives receive larger support in large elections, since expressive preferences become more important as the likelihood of being pivotal decreases (Feddersen et al., 2009; Shayo and Harel, 2012). Thus, it is unclear whether the differences across voting methods that we observe will persist with large electorates. Hence, it is important to establish the external validity of the results. For this purpose, we carried out a large-scale experiment with two treatments. Each treatment involved 1,200 voters, for a total of 2,400 unique voters (1,593 female). Participants were recruited using the online research platform Prolific (Palan and Schitter, 2018) from a large subject pool consisting of UK residents. The experiment was programmed and conducted with Qualtrics. We used the payoff profiles of Societies 3 and 4 in order to show that the results of the SE experiment extend to large electorates.

In each large-electorate (LE) treatment, we assigned 400 voters to each of the three possible types, magnifying Societies 3 and 4 by a factor of 200. We refer to them as Large Electorate-3 (LE-3) and 4 (LE-4), respectively. Implementation was as in SE, with the exception that each experiment involved one society only and that each voter was assigned to a fixed type. That is, in contrast to SE, each LE treatment corresponds to a single, large election. Voters were aware of the size of the electorate and hence of the fact that, as in actual elections, their individual vote was practically negligible. In each treatment, voters cast votes according to all three methods (PV, AV, and BC). The objective was to show that the results described above transfer to large electorates, in spite of the noisier environment typical of online experiments.

The exchange rate for payoffs was 0.03 GBP for 1 ECU (equivalent to $0.037 at the time of the experiment). The experiment took on average 8 minutes and subjects received an average payoff of 1.95 GBP (about 2.16 EUR at the time of the experiment).

3.4 Procedures: Medium Electorates

In SE and LE electorates were symmetric in the sense that they were split into three, equally-sized interest groups. Although we believe that this captures important fea-

[7] Subjects did not face the exact same profile three times, but rather three slightly different profiles that were obtained from the profiles presented in Table 1 and Figures 1.A to 4.A via small random perturbations (jittering) keeping all its qualitative features unchanged.

tures of polarized societies, it is clear that actual electorates typically are not perfectly symmetric. As previous work indicates that group size may affect willingness to compromise (Posner, 2004; Huber, 2012), it is important to study asymmetric electorates with interest groups of different sizes. To that end, we conducted an additional Medium Electorates (ME) online experiment (in Prolific, using a sample of UK residents) that varied the size of the three interest groups represented by the different voter types in two between-subject treatments. In each treatment 30 subjects formed a medium-sized electorate and took part in eight elections with five alternatives. Each election used a different voting method: PV, AV, BC, and the random dictator mechanism. Both treatments used the two payoff profiles corresponding to Societies 3 and 4. In contrast to the SE experiment, subjects were randomly assigned to a fixed type for each society. In treatment HOM the electorate was symmetric (as in SE and LE), whereas in treatment HET it was asymmetric (see details in Section 4.3). The treatments involved $1,620$ voters each, for a total of $3,240$ unique voters (1,985 female) and $19,440$ voting decisions. We again focused on the payoff profiles of Societies 3 and 4.

The exchange rate for payoffs was as in the LE experiment. The experiment took on average 10 minutes and subjects received an average payoff of 1.99 GBP (about 2.31 EUR at the time of the experiment).

4 Results

4.1 Small Electorates

To compare voting behavior within and across methods, we measure a voter's support for an alternative for a given voting method as follows. For PV, we use a binary variable indicating whether an alternative was chosen. For AV, we take the normalized approval score, that is, we normalize approvals by the number of approvals cast by a voter. For BC, we take a normalized score computed as the number of points assigned to an alternative divided by the total number of points allocated. For expositional simplicity, we refer to the resulting measures for all three voting methods as the "level of support" by a voter for an alternative under a particular voting method. All tests involving the level of support below are nonparametric Wilcoxon Signed-Rank tests (WSR) conducted at the individual level ($N = 180$), with reported p-values corrected for multiple testing using the Holm-Bonferroni method (Holm, 1979) whenever necessary.

4.1.1 Society 1

Society 1 pitted egoistical behavior against an equality-based compromise. Figure 1A repeats the payoffs and induced preferences as given in Table 1. Monetary payoffs (Fig. 1A, top) were such that the induced self-centered preferences for each type (Fig. 1A, bottom) put the own Self-Interest option on top and the equality-based alternative second; hence the latter was a morally-attractive compromise for all voters and a natural

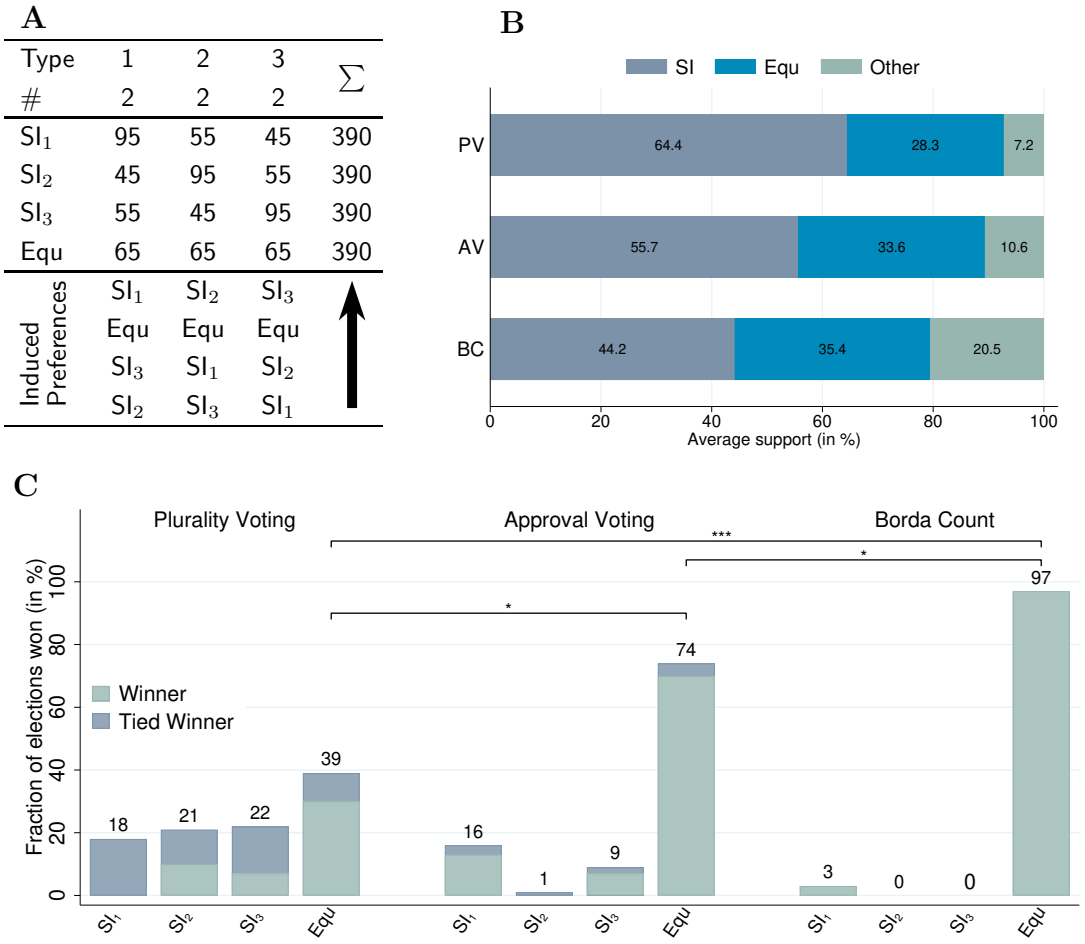

Figure 1: Preferences, voting behavior, and outcomes for Society 1.

Notes: **A**, Voter preferences in each electorate, induced monetarily. **B**, Aggregate voting behavior for the 180 voters. **C**, Voting outcomes for the 30 electorates, by voting method. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

focal point for coordination. Types were identical up to a relabeling of the alternatives and hence the analysis (in terms of whether voters voted for SI or Equ) does not need to distinguish among them. Each voter participated in Society 1 three times, once per voting method.

Figure 1B displays aggregate voting behavior in Society 1, where SI stands for support for the own Self Interest option. The support for Self Interest options is significantly larger than the support for Equity for all three voting methods (all $p < 0.001$). This shows a failure of Equity to serve as a "moral root" facilitating the selection of a compromise. However, average support for Equity is still substantial, confirming that it represents a socially-desirable compromise, and it increases from 28.3% under PV to 33.6% under AV and 35.4% under BC. The advantage in the level of support for Self-Interest over Equity (difference between the variables defined above) is larger under PV than under either AV or BC (PV vs. AV, $p = 0.028$; PV vs. BC, $p < 0.001$). That is,

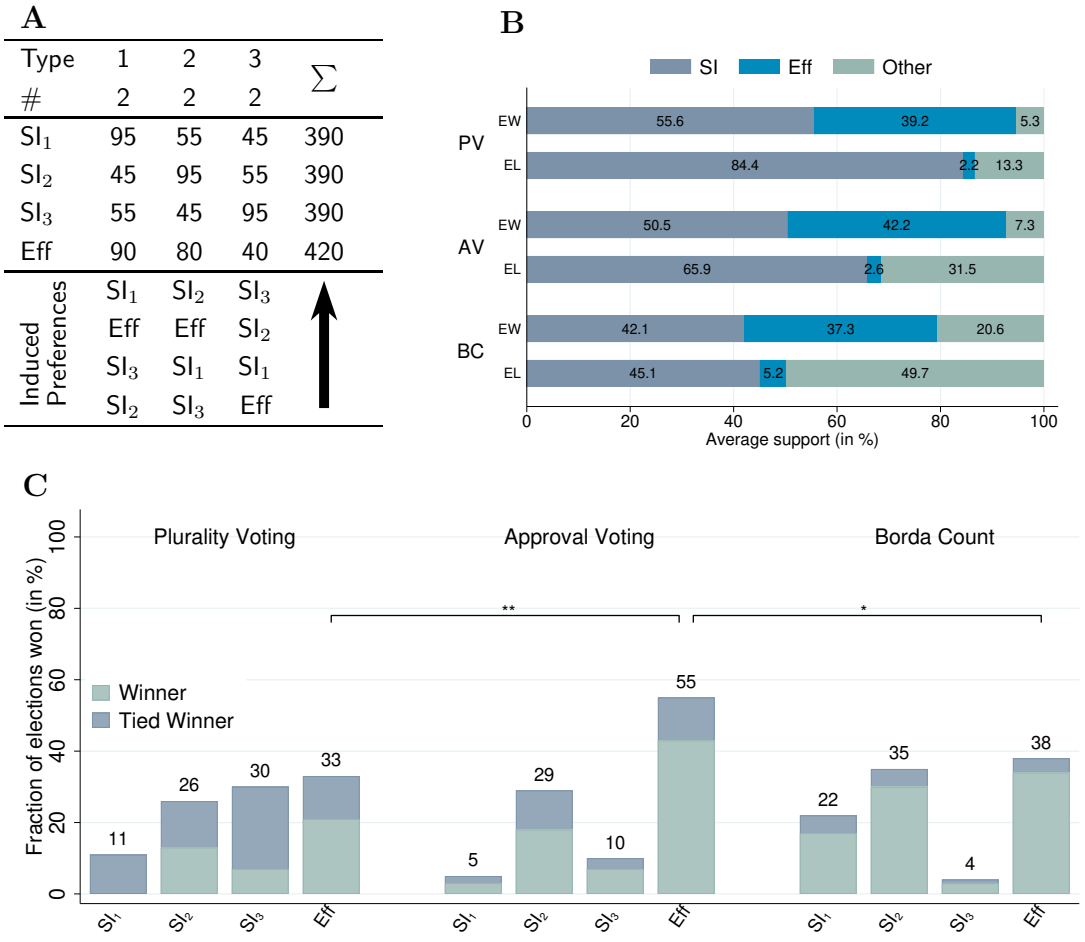

Figure 2: Preferences, voting behavior, and outcomes for Society 2.

Notes: **A**, Voter preferences in each electorate, induced monetarily. **B**, Aggregate voting behavior for the 180 voters. **C**, Voting outcomes for the 30 electorates, by voting method. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

AV and BC mitigate the focus on Self-Interest, leading to a significant increase in the share of votes received by Equity.

Figure 1C displays the percentage of the time that an option won the election in Society 1, with ties broken randomly, across different voting methods. All tests on voting outcomes below are WSR tests conducted at the electorate level ($N = 30$), with p-values corrected using the Holm-Bonferroni method (Holm, 1979) whenever necessary. The apparently-modest increase in support for Equity has a very large impact on actual voting outcomes. Under PV, there is a large number of ties (paralleling knife-edge results in large elections) and the outcome typically favors the self-interest of just one voter subgroup, with Equity winning only 38.9% of the elections. In contrast, AV implements Equity in an astounding 74.2% of the elections, significantly more than under PV based on the number of elections won per electorate ($p = 0.012$). The results under BC are even more extreme, with Equity winning almost universally (in 96.7% of the elections), significantly more often than under PV ($p < 0.001$) and under AV ($p = 0.013$).

In terms of outcomes, the results are roughly aligned with the normative predictions assuming *sincere* voting (recall Section 3.1), with some differences. Under PV, sincere voting predicts a three-way tie among self-interest options in all four societies. This is essentially in line with the results, where self-interest options won more often with no clear differences among them, and reflects the knife-edge nature of electoral results under polarization. However, even under PV, and contrary to the prediction, Equity does win a significant fraction of the elections, reflecting the generalized support that this principle enjoys (recall the discussion in the Introduction).

Under BC, Equity is the predicted winner assuming sincere voting. Empirically, this is overwhelmingly the case. Under AV, Equity is also the predicted winner under AV (both assuming AV_2 and AV_3). Again, this is by far the most frequent winner for this method, but still roughly one quarter of the elections result in the selection of a self-interest option. Overall, in spite of our *caveats* (strategic voting and social preferences), the theoretical predictions are essentially reflected by the data for Society 1.

4.1.2 Society 2

Society 2 pitted egoistical behavior against an efficiency-based compromise which yielded a strictly higher total payoff to the overall electorate (Fig. 2A). The payoff distribution for Efficiency creates inequality, with two types (four voters) being Efficiency Winners (EWs) and the remaining type (two voters) being Efficiency Losers (ELs). That is, Efficiency benefits a majority of the electorate. Voters participated in Society 2 three times for each voting method, and each time they were assigned to a different voter type.

Figure 2B displays aggregate voting behavior in Society 2, distinguishing EWs and ELs, and focusing on the comparison of SI and Eff. ELs are very close to fully-selfish behavior, displaying almost no support for Efficiency in any method (PV: 2.2%, AV: 2.6%, BC: 5.2%), in particular below their support for Self-Interest (all $p < 0.001$). However, the advantage in support for Self-Interest over Efficiency for ELs is significantly larger for PV than under either AV or BC (both $p < 0.001$). For EWs, we pool decisions for types 1 and 2 (since induced preferences were identical up to relabeling of alternatives) and define their level of support for an alternative as the average across their two decisions made as EW. Their support is split between SI and Efficiency, with the average support for the former being slightly larger for all three methods (all $p < 0.001$). That is, EWs appear to be torn between Efficiency and Self-Interest, while ELs essentially focus exclusively on Self-Interest although to a lesser extent under AV and BC.

Again, the apparently-small differences in voting behavior across methods are enough to induce substantial differences in actual voting outcomes (Fig. 2C). PV leads to frequent ties among the Self-Interest alternatives, with Efficiency winning only 33.1% of the elections. In contrast, under AV the efficient outcome wins 55.0% of the elections, significantly more than under PV ($p = 0.003$). Under BC, Efficiency wins 38.3% of the elections, significantly less often than under AV ($p = 0.037$), but not significantly

different from PV ($p = 0.248$). That is, when an Efficiency option favoring a majority is available (but no Equity option is), AV is more often able to elicit clear majorities for it, while BC is not.

Comparing outcomes to the predictions under sincere voting, we see that, as expected, the majority of the outcomes under PV correspond to self-interest options. However, analogously to in Society 1, and contrary to the theoretical predictions, Efficiency does win around a third of the elections. The predictions for BC and AV under sincere voting did not particularly favor Efficiency. Under AV_2, Efficiency and SI_2 should win equally frequently, and under AV_3 SI_1 should be the only winner. For BC there should be a tie between SI_1 and SI_2. Empirically, the results are very different and favor compromises far more than sincere voting would justify. Under AV, Efficiency is the most-frequent winner, even though a majority of elections are won by SI_1 and SI_2. Under BC, Efficiency wins most of the elections.

4.1.3 Society 3

While Societies 1 and 2 confronted Self-Interest with either Equity or Efficiency in isolation, in Societies 3 and 4 both social conventions were present (hence five alternatives were available). Efficiency creates inequality in both societies, but they differ in whether a majority or just a minority benefits. Society 3 is characterized by a majority of Efficiency Winners if Efficiency is selected. This society allows us to study both self-centered choices and the equity-efficiency trade-off in a situation where a majority of the electorate benefits from Efficiency, and hence the latter could be argued to be a democratic ideal.

Figure 3A details the payoffs and induced preferences in Society 3. Figure 3B summarizes actual aggregate voting behavior. EWs tend to support Efficiency (PV: 37.5%; AV: 38.1%; BC: 31.7%) over Equity (PV: 8.1%; AV: 11.6%; BC: 21.6%; all three methods $p < 0.001$). For ELs, support for Efficiency is virtually nonexistent (PV: 2.8%; AV: 1.9%; BC: 2.3%), and far smaller than their support for Equity (PV: 26.1%; AV: 34.1%; BC: 29.8%; all three methods $p < 0.001$). However, for all methods, Self-Interest options receive a larger support than Efficiency for EWs (PV, $p = 0.038$; AV, $p = 0.007$; BC, $p = 0.048$), although the difference is small for AV and BC. Self-Interest options also receive a clearly larger support than Equity for ELs (all three methods $p < 0.001$).

Again, differences in voting behavior result in considerable differences in voting outcomes (Fig. 3C). Under PV, SI options win most of the time (54.3%), while under AV and BC the most-frequent winners are Efficiency (58.2%) and Equity (64.8%), respectively. Efficiency wins most frequently under AV (AV vs. PV, $p = 0.002$; AV vs. BC, $p < 0.001$), and Equity wins most elections under BC, compared to both PV and AV (both $p < 0.001$). Equity still fares significantly better under AV than under PV ($p = 0.017$). Indeed, under AV SI options only win 18.9% of the elections, and only 9.3% under BC. That is, while Self-Interest often wins the upper hand under PV, each

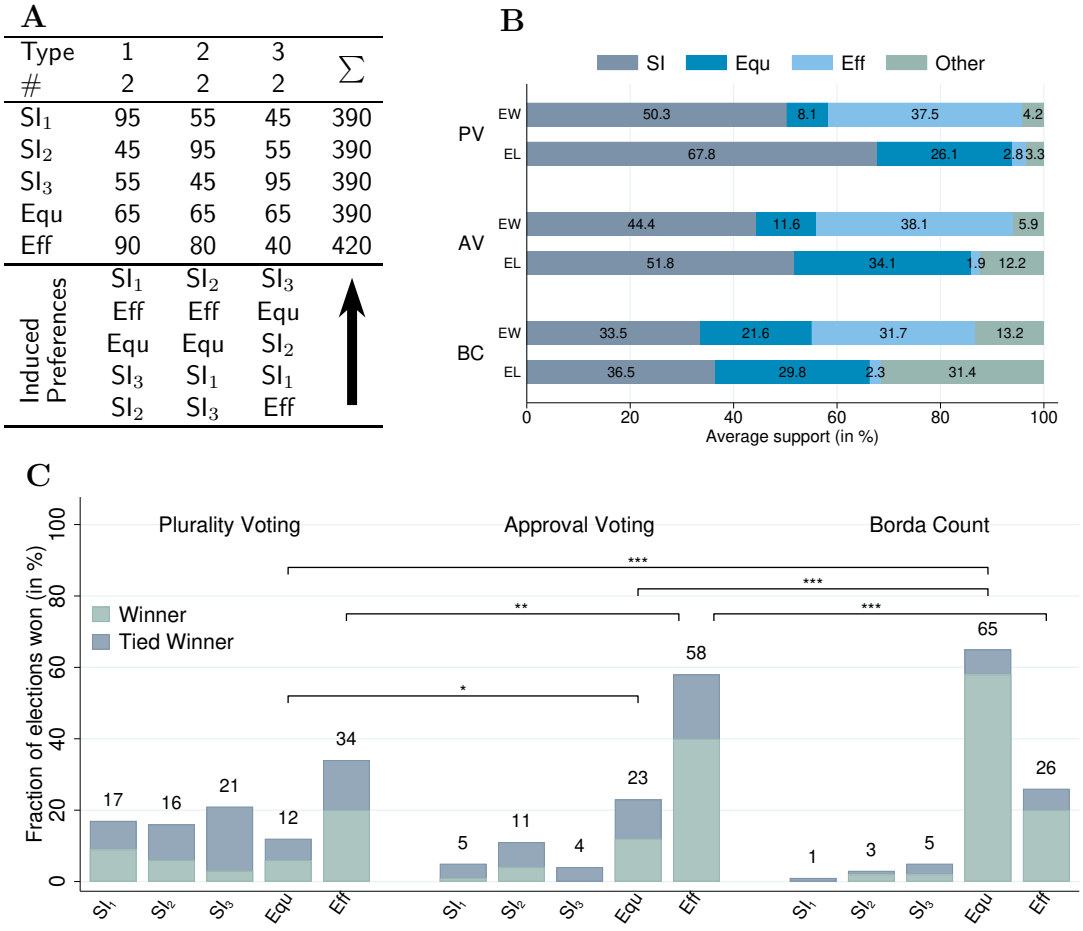

Figure 3: Preferences, voting behavior, and outcomes for Society 3.

Notes: **A**, Voter preferences in each electorate, induced monetarily. **B**, Aggregate voting behavior for the 180 voters. **C**, Voting outcomes for the 30 electorates, by voting method. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

of the alternative voting methods manages to select a desirable social convention as an acceptable compromise, which goes on to win most elections. The methods clearly differ, with AV favoring Efficiency and BC selecting Equity.

Comparing outcomes to the predictions under sincere voting, and as in Societies 1 and 2, under PV self-interest options win most of the elections as predicted, but, contrary to the prediction, Equity and Efficiency do win a significant fraction of the elections, reflecting the generalized support that these principles enjoy. Under sincere voting, both AV and BC are predicted to select one of the compromise options, Equity in the case of BC and either Efficiency or Equity for AV, depending on whether one focuses on AV_2 or AV_3, respectively. Equity is indeed the most frequent winner under BC, but, contrary to the sincere-voting prediction, Efficiency does win a quarter of the elections. Conversely, Efficiency is the most frequent winner under AV, but Equity still wins a quarter of the elections.

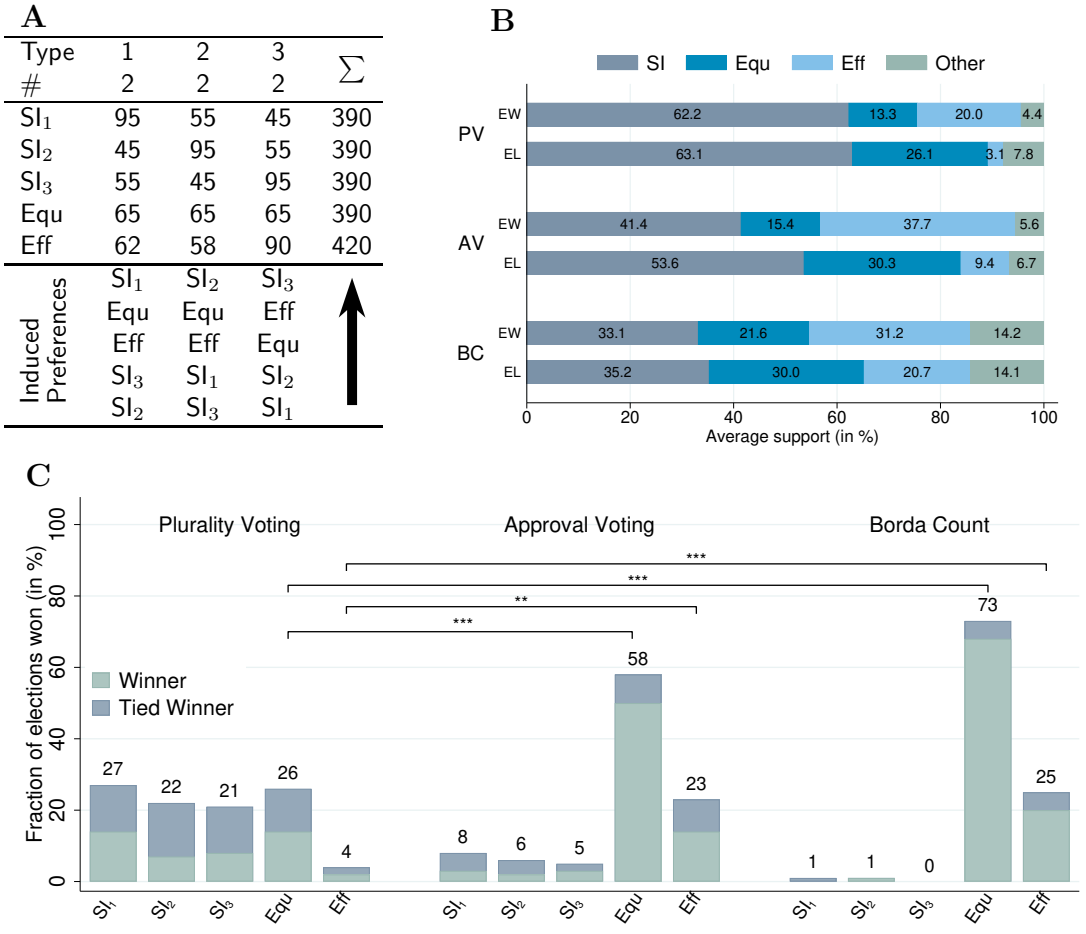

Figure 4: Preferences, voting behavior, and outcomes for Society 4.

Notes: **A**, Voter preferences in each electorate, induced monetarily. **B**, Aggregate voting behavior for the 180 voters. **C**, Voting outcomes for the 30 electorates, by voting method. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4.1.4 Society 4

Finally, in Society 4 both Equity and Efficiency are available alternatives, but if Efficiency were implemented a majority of the electorate would be worse off, i.e. there is a majority of ELs (Fig. 4A). Figure 4B summarizes actual aggregate voting behavior for Society 4, separately for EWs and ELs. As in Society 3, EWs tend to support Efficiency (PV: 20.0%; AV: 37.7%; BC: 31.2%) over Equity (PV: 13.3%; AV: 15.4%; BC: 21.6%; PV, $p = 0.121$; AV and BC, $p < 0.001$). For ELs, support for Efficiency (PV: 3.1%; AV: 9.4%; BC: 20.7%) is much smaller than support for Equity (PV: 26.1%; AV: 30.3%; BC: 30.0%; all three methods $p < 0.001$). Self-Interest options receive a larger support than Efficiency for EWs under PV ($p < 0.001$), but, as in Society 3, the differences are small under both AV and BC (AV, $p = 0.136$; BC, $p = 0.065$). Self-Interest options receive a clearly larger support than Equity for ELs (all three methods $p < 0.001$).

Under PV, the average support received by Efficiency from EWs is almost cut in half in Society 4 (where efficiency benefits only a few) compared to Society 3 (where

efficiency benefits a majority; $p < 0.001$). Thus, there is a clear "wasted vote" effect for EWs under PV when they are in the minority, as they realize that their favorite option has no chance of winning and hence strategically misrepresent their preferences. This effect is absent under AV ($p = 0.557$) and BC ($p = 0.804$). For ELs, support for Self-Interest and Equity are very similar in Societies 3 and 4. However, Efficiency also receives some support from ELs under AV (9.4%) and BC (20.7%) in Society 4. This is likely due to the fact that, compared to Society 3, a larger group of ELs shares the losses relative to Equity, and in terms of payoffs the comparison of Efficiency and Equity is less aversive.

Differences in voting outcomes are also large for Society 4 (Fig. 4C). Under PV, SI options win an overwhelming 70.4% of the time. In contrast, the most-frequent winner under both AV and BC is Equity (AV, 57.8%; BC, 72.8%), and both select it significantly more often than PV (both $p = 0.001$). Since PV mostly selects Self-Interest, also Efficiency is selected more often under AV ($p = 0.002$) and BC ($p < 0.001$). There is no significant difference in outcomes between AV and BC. That is, on the one hand, Society 4 confirms the previous observation that Self-Interest wins often under PV but the other methods manage to shift the balance to desirable conventions. On the other hand, putting Societies 3 and 4 together we see that BC is non-responsive in the sense that it favors Equity independently of whether a majority or just a minority benefits from Efficiency, while AV is highly responsive to the latter distinction, favoring Efficiency only when the majority profits from it, and shifting support to Equity otherwise.

For PV, the comparison of outcomes to the predictions under sincere voting is analogous to that of Societies 1–3. As predicted, self-interest options win most of the elections, but, contrary to the prediction, Equity and Efficiency (but mostly Equity) do win around a third of the elections. Under sincere voting, both AV and BC are predicted to select Equity (tied with Efficiency for AV_3), and this is indeed the most frequent winner by far for both methods. In both cases, however, Efficiency wins around a quarter of the elections.

4.2 Large Electorates

We now look at voting behavior and voting outcomes for both large electorates across voting methods. Since each LE treatment captured a single election per method, outcomes correspond to the actual, overall winners. Both average voting behavior and election outcomes show exactly the same trends in LE as in SE.

For LE-3, under PV, each of the three SI options received more votes (≥ 263) than either Equity (196) or Efficiency (188), consequently one of the self-interest options (SI_3) won the election. In contrast, under AV both Equity (655) and Efficiency (692) received more approvals than any SI option (≤ 551), with Efficiency winning the election. Under BC, again both Equity (2786) and Efficiency (2592) received more points than any SI option (≤ 2281), and Equity emerged as the winner. That is, while Self-Interest won the

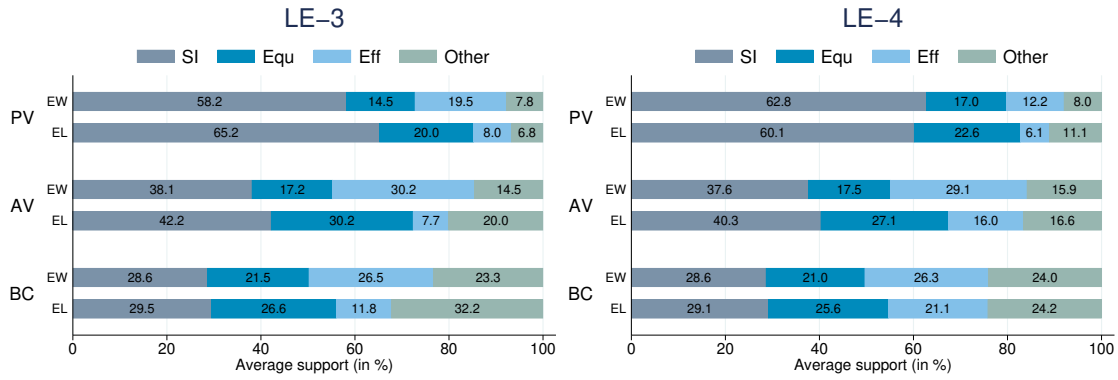

Figure 5: Aggregate voting behavior for large electorates.

upper hand in LE-3 under PV, each of the alternative voting methods managed to select a desirable social convention as an acceptable compromise. This reproduces the results from the laboratory experiment (Society 3) and confirms that the methods clearly differ, with AV favoring Efficiency and BC selecting Equity.

Figure 5 (left panel) summarizes aggregate voting behavior across voting methods for LE-3, separately for EWs and ELs. All comparisons are as in the small electorates. EWs tend to support Efficiency (PV: 19.5%; AV: 30.2%; BC: 26.5%) over Equity (PV: 14.5%; AV: 17.2%; BC: 21.5%; WSR test, $N = 800$; PV, $p = 0.018$; AV and BC, $p < 0.001$). For ELs, support for Efficiency is very low (PV: 8.0%; AV: 7.7%; BC: 11.8%), and in particular lower than their support for Equity (PV: 20.0%; AV: 30.2%; BC: 26.6%; WSR test, $N = 400$; all three methods $p < 0.001$). Self-Interest options receive a larger support than Efficiency for EWs (all three methods $p < 0.001$), although the difference is small for AV and BC. Self-Interest options also receive a clearly larger support than Equity for ELs (all three methods $p < 0.001$). In summary, all previous conclusions for Society 3 hold in a large electorate.

The second treatment (LE-4) reproduced Society 4 for a large electorate. Again, voting behavior and outcomes paralleled the results from the small electorates, with large differences in voting margins. Under PV, each of the three SI options received more votes (≥ 275) than either Equity (249) or Efficiency (98), and consequently one of the self-interest options (SI_3) won the election. In contrast, under AV both Equity (725) and Efficiency (677) received more approvals than any SI option (≤ 556), and Equity won the election by a large margin. Under BC, both Equity (2888) and Efficiency (2740) also received more points than any SI option (≤ 2175), and Equity emerged again as the winner with a large advantage over SI options. That is, as in the small electorates, Self-Interest won the upper hand in our large electorate under PV, and both alternative voting methods selected Equity as an acceptable compromise. On the one hand, LE-4 confirms the previous observation that Self-Interest wins often under PV but the other methods manage to shift the balance to desirable conventions. On the other hand, comparing LE-3 and LE-4 confirms the previous comparison between Societies 3 and 4.

BC favors Equity independently of whether a majority or just a minority benefits from Efficiency, while AV responds to the latter distinction, favoring Efficiency only when the majority profits from it, and shifting support to Equity otherwise.

Figure 5 (right panel) summarizes aggregate voting behavior across voting methods for LE-4, separately for EWs and ELs. Again, EWs tended to support Efficiency (PV: 12.2%; AV: 29.1%; BC: 26.3%) over Equity (PV: 17.0%; AV: 17.5%; BC: 21.0%) under AV and BC (both $p < 0.001$), whereas the opposite holds under PV ($p = 0.096$). For ELs, support for Efficiency (PV: 6.1%; AV: 16.0%; BC: 21.1%) is much smaller than support for Equity (PV: 22.6%; AV: 27.1%; BC: 25.6%; all three methods $p < 0.001$). Self-Interest options receive a larger support than Efficiency for EWs under PV ($p < 0.001$); as in LE-3, differences are small under both AV and BC, but remain statistically significant (AV, $p < 0.001$; BC, $p = 0.001$). Self-Interest options receive a clearly larger support than Equity for ELs (all three methods $p < 0.001$). All conclusions are as in Society 4 in the small electorates.

All previous conclusions comparing Societies 3 and 4 are supported for large electorates (the comparison is now between subjects). Under PV, support for Efficiency from EWs is almost halved in LE-4 compared to LE-3 (Wilcoxon Rank-Sum test, WRS, $N = 1200$; PV, $p = 0.002$), confirming the "wasted vote" effect for EWs under PV when they are in the minority. This effect is absent under AV and BC, with the EWs' support for Efficiency being of comparable magnitude in both societies (AV, $p = 0.432$; BC, $p = 0.474$). For ELs, support for Self-Interest and Equity are very similar in both societies. However, Efficiency also receives larger support from ELs under AV (16.0%) and BC (21.1%) in LE-4 than in LE-3 (both $p < 0.001$).

We conclude that the results obtained in our laboratory experiments are not limited to small electorates. The conclusion that alternative voting methods allow electorates to successfully select socially desirable compromises extends to large electorates, as does the observation that BC favors Equity, while AV supports Efficiency provided a majority benefits from it.

4.3 Medium (and Asymmetric) Electorates

In the ME experiment, in treatment HOM we assigned 10 voters to each of the three possible types in Society 3 (HOM-3) and Society 4 (HOM-4). In HET, the distribution of types was asymmetric. In Society 3 of HET (HET-3), 8 voters were assigned to type 1, 9 to type 2, and 13 voters to type 3, increasing the size of the minority group of ELs relative to HOM-3. This asymmetry between voter types in HET-3 affects the efficiency of alternatives in two ways: First, the three Self-Interest alternatives differ in terms of efficiency with SI_1 being the least and SI_3 the most efficient of those alternatives. Second, while Eff remains the efficient compromise in the sense of being more efficient than Equ, it is now less efficient overall compared to SI_3. In Society 4 of HET (HET-4), 9 voters were assigned to type 1, 8 to type 2, and 13 to type 3, increasing the size of the

minority group of EWs relative to HOM-4. As in HET-3, the three Self-Interest options differ in terms of efficiency, but now SI_1 and SI_2 are the most and least efficient of those alternatives, respectively. In contrast to HET-3, however, Eff remains the alternative with the highest efficiency overall.

The predictions under sincere voting for medium electorates are qualitatively similar to Societies 3 and 4 in SE (see Appendix F for details). Under PV, sincere voting predicts a specific self-interest option rather than a tie, and zero support for Equity and Efficiency. BC predicts Equity, and AV predicts either Equity or Efficiency.

The results of HOM closely replicate all results obtained for Societies 3 and 4 in SE (see Appendix A for details), hence we turn to compare HOM and HET. In HET-3, the electorate was not only asymmetric, but as a consequence of this asymmetry the advantage in terms of efficiency of the efficient compromise Eff over equity was also much smaller compared to HOM-3. Although voting behavior is rather similar in both treatments, the difference in the size of the three interest groups have a clear effect on voting outcomes in HET-3. Under PV, SI options win almost all elections (92.6%), while under AV and BC the most-frequent winner is Equ (AV: 60.2%; BC: 76.9%). Under AV and BC, SI options win only 24.1% and 17.6% of the elections, respectively. That is, while Self-Interest almost always wins the upper hand under PV, each of the alternative voting methods manages to select a desirable social convention. In contrast to HOM-3, AV selects Equ in HET-3, which yields two interesting insights: First, it shows that AV is also sensitive to whether the efficiency gain is small or large, selecting Efficiency in HOM-3, where it is large and Equity in HET-3, where it is small. Second, although in HET-3 alternative SI_3 is overall the most efficient option (since voters of type 3 form the largest interest group), it is not selected by AV.

Next, we consider Society 4. In HET-4, EWs are still a minority but now form the largest of the three interest groups. Consequently, the efficient compromise Eff is even more efficient in HET-4 than in HOM-4. Again, there are no large differences in voting behavior across treatments, however, the same cannot be said about voting outcomes. Under PV, SI options win an overwhelming 88.6% of the time in HET-4. In contrast, under both AV and BC Equ emerges as the winner most of the time (AV, 56.5%; BC, 57.4%). As in HOM-4, equity is selected by both AV and BC, however, both methods react to the overall greater efficiency of Eff by selecting it more frequently in HET-4 than in HOM-4.

In summary, HOM shows that our previous results for small and large electorates also obtain for medium-sized electorates. A comparison of HOM and HET reveals that all voting methods react to differences in the size of the interest groups. Under PV, an asymmetric electorate leads to even more extreme outcomes with selfish options winning almost all elections. In contrast, AV and BC also allow the asymmetric electorate to successfully select socially desirable compromises. For those methods, the asymmetry merely affects the frequency with which one or the other compromise is selected.

5 Sincerity and Consistency

One of the main objectives of a voting method is to represent the electorate's preferences as faithfully as possible (e.g., Riker, 1982). Both theoretical and empirical arguments suggest that strategic voting could be widespread (recall Section 3.1). One can of course argue whether or not manipulation attempts at the individual level should be a concern (Dowding and van Hees, 2008), and the results of our experiments suggest that deviations, at least in our experimental societies, tend to favor compromises. However, it is still important to know which methods elicit a higher degree of strategic behavior in actual voting decisions. Thus, we now take a closer look at strategic voting and the sincerity of voters' behavior in our data.

Differences in strategic voting across methods are especially interesting in our experimental settings, because Approval Voting does not belong to the class covered by the formal results of Gibbard (1973) and Satterthwaite (1975) and at least partially escapes them (Brams and Fishburn, 1978; Alós-Ferrer and Buckenmaier, 2019). The intuition is that, even if there are strategic reasons to approve of a non-favorite option, this can be accomplished by merely moving the approval threshold without misrepresenting preferences (see, however, Niemi, 1984).

In our experimental societies, we induced preferences via monetary payoffs. The behavioral literature mostly considers sincerity with respect to the preferences induced in this way. However, a large literature in economics and political science shows that preferences take into account both inequality and efficiency (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Feddersen et al., 2009; Bechtel et al., 2018; Morton and Ou, 2019). Hence, our voters' true preferences may differ from monetarily-induced ones. Since our experimental setup focuses on social conventions, it is likely that non-egoistic motives play a role. For that reason, our laboratory experiment implemented a novel preference-elicitation method (presented as a fourth voting method) based on a random dictator mechanism. To that end, subjects were first asked to choose an alternative that, in case the subject was randomly selected to be the dictator, would be implemented independently of the decisions of the other voters in the group. In order to elicit the full preference over alternatives and not just the most-preferred alternative, subjects were informed that for each alternative there was a small probability of 5% that this alternative could not be implemented. Hence, subjects were asked to name a second alternative to be implemented in case their first choice was not feasible. Continuing in that fashion subjects had to sequentially provide a complete ranking of the alternatives. Payment for this method was implemented truthfully, that is, a voter was randomly selected and the most-preferred alternative of this voter was implemented with a probability of 95%, and eliminated from the ranking otherwise; in the latter case, the procedure was repeated with the reduced ranking. This method elicits preferences in an incentive-compatible way, with incentives being fully independent from the decisions of the other voters. We refer to the ranking so obtained as a subject's *elicited preferences*.

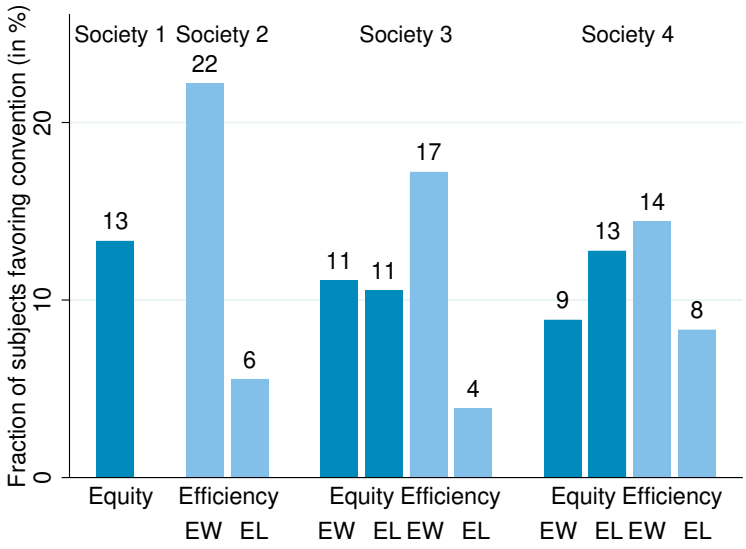

Figure 6: Elicited preferences for small electorates.

Notes: Fraction of subjects who favor Equity or Efficiency over Self-Interest at least once, according to their elicited preferences.

By construction Self-Interest is always the most preferred alternative according to voters' induced preferences. In our Small Electorates, a small but still sizable fraction of voters prefers one of the social conventions, Equity (11-13%) or Efficiency (10-17%), to implementing their payoff-maximizing alternative at least once according to their elicited preferences (Fig. 6). For those voters, the induced preference profile does not always coincide with their preferences as revealed by the elicitation mechanism. Thus we obtain a novel measure of sincerity. We refer to the classic notion of sincerity relative to the induced preferences as *induced sincerity*, and to our alternative measure of sincerity relative to the elicited preferences as *elicited sincerity*. Specifically, we define sincerity (induced or elicited) over a set of alternatives as follows. For PV, the only sincere vote is to vote for the most-preferred alternative. For AV, a ballot is sincere if it approves of any alternative that is (strictly) preferred to some approved alternative. For BC, the only sincere vote is to rank the alternatives from most-preferred to least-preferred.

Focusing on elicited sincerity for SE, we find a large fraction of insincere votes under PV, except for efficiency losers in Society 2 (Fig. 7). In contrast, we find high levels of sincerity under AV and no systematic difference in sincerity between EWs and ELs (WSR tests, $N = 180$; Soc. 2, $p = 0.046$; Soc. 3, $p = 0.056$; Soc. 4, $p = 0.360$). Under BC there is also a large fraction of insincere votes, with a stronger tendency toward strategic voting for EWs compared to ELs (Soc. 2, $p < 0.001$; Soc. 3, $p = 0.078$; Soc. 4, $p = 0.003$). However, for BC sincerity is a very demanding concept, as it requires subjects to truly state their complete preference ranking and not just the top-ranked one as it is the case for PV. Given this, the fact that sincerity in BC is of a similar magnitude than in PV means that BC did not exacerbate insincerity in our data. Interestingly, voters in the

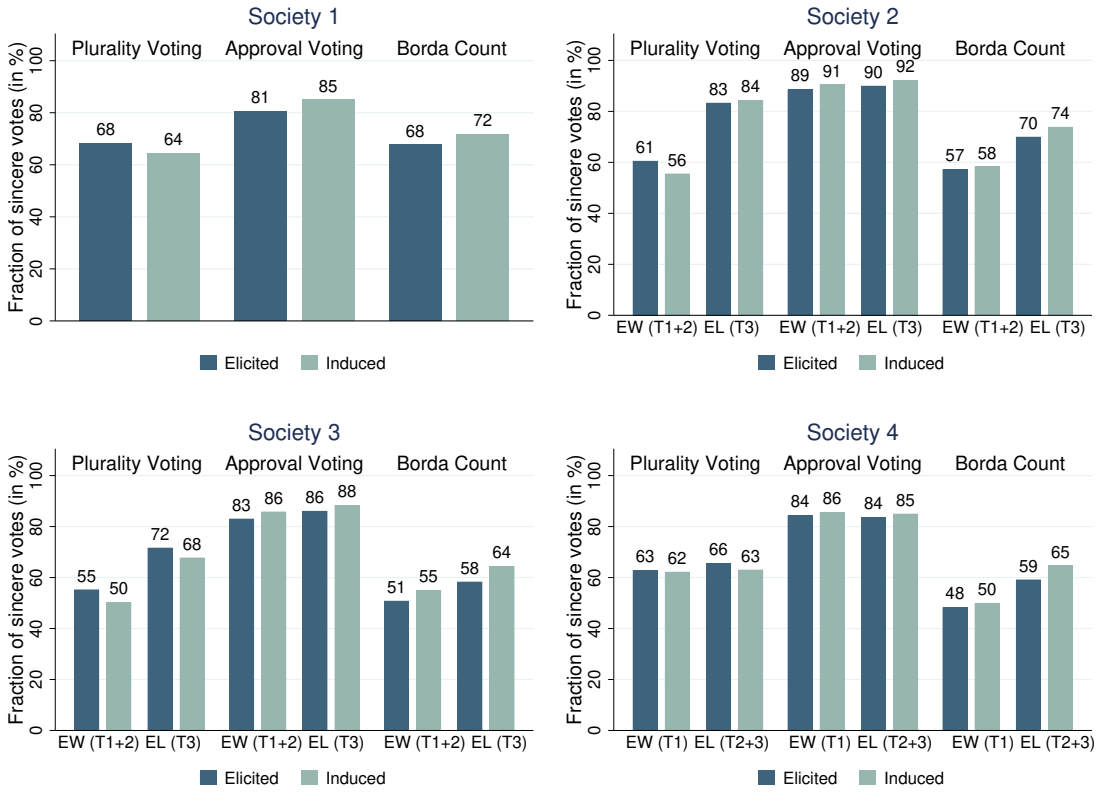

Figure 7: Induced and elicited sincere votes for small electorates.

Notes: Fraction of induced/elicited sincere votes for each voting method in the four experimental societies.

minority show more strategic voting under BC compared to PV (Soc. 2, ELs, $p < 0.001$; Soc. 3, ELs, $p = 0.003$; Soc. 4, EWs, $p = 0.001$), while the majority shows no such effect (Soc. 2, EWs, $p = 0.471$; Soc. 3, EWs, $p = 0.138$; Soc. 4, ELs, $p = 0.073$). We also find that the overall level of sincerity is qualitatively the same with respect to both the induced and the elicited preferences (17 out of 21 tests are insignificant).

For Large Electorates, we can also examine induced sincerity. Overall sincerity seems to be lower than in the laboratory. However, the relative magnitudes of sincerity across voting methods and EW/EL are again very similar. We find a large fraction of insincere votes under PV (Appendix B, Fig. A.5) with a stronger tendency toward strategic voting for EWs compared to ELs in LE-3 (WRS test, $N = 1200$, $p = 0.020$). In contrast, we find high levels of sincerity under AV and no systematic difference in sincerity between EWs and ELs (WRS tests, $N = 1200$; LE-3, $p = 0.643$; LE-4, $p = 1.000$). Under BC there is also a large fraction of insincere votes and no difference between EWs and ELs (WRS tests, $N = 1200$; LE-3, $p = 1.000$; LE-4, $p = 0.935$).

The ME experiment also featured our preference-elicitation method, hence, we can consider both induced and elicited sincerity. A small but still sizable fraction of voters prefers one of the social conventions, Equity (20-22%) or Efficiency (16-19%), to im-

plementing their payoff-maximizing alternative at least once according to their elicited preferences. The proportions are very similar for Medium Electorates (Appendix B, Fig. A.6). Regarding elicited sincerity, results for treatment HOM in ME are very similar to those of SE. For HET there is a stronger tendency for strategic voting under BC for EWs compared to ELs in Society 3, whereas we find the opposite for Society 4 (see details in Appendix B).

A different way to examine whether some voting method is especially prone to manipulations (strategic behavior) is to examine voter consistency across methods. We say that behavior for PV is *consistent* with AV if the alternative voted for under PV is contained in the set of approved alternatives under AV. PV is *consistent* with BC if the alternative voted for under PV is the top-ranked alternative under BC. AV is *consistent* with BC if the AV set is a top segment in the BC ranking. Results are very similar across all three experiments. We find a high consistency between PV and AV. Consistency of PV with BC is systematically lower than consistency of AV with BC. We also observe that, for EWs, consistency is lowest between PV and BC, possibly indicating that EWs are particularly prone to strategic behavior under BC. See Appendix C for details.

6 Rank-Order Methods

Our experiments focused on three prominent voting methods: PV, AV, and BC. Naturally, there are many other interesting voting methods that could have been used as well. Two relevant examples are the rank-order voting methods Single Transferable Vote (STV), used e.g. for the election of the Australian Parliament, and the two-round system (TRS) used in the French presidential elections. Although those methods were not included in our experiments, we can use the preference rankings elicited via the random dictator mechanism to infer the outcomes that would be obtained under those voting procedures by extrapolation based on those elicited preferences (see Felsenthal et al., 1993; Felsenthal and Machover, 1995, for a similar approach employed in a field setting). In this section we report the results of this exercise for small and medium electorates, which featured the random dictator mechanism (Appendix E provides further details of these analyses).[8]

We first consider the induced election outcomes under STV for small electorates. Voting outcomes exhibit a large number of ties, with self-interest options winning an overwhelming amount of elections. Across the four societies, equity and efficiency win only between 5% and 8% of the elections, which suggests that outcomes under STV (assuming that voters vote according to their elicited preferences) would be even more extreme than under PV. For small electorates, the outcomes under TRS are exactly identical.

[8]For LE, we conducted a similar exercise based on the preference ranking induced by subjects' BC vote. These results are presented in Appendix E. Under STV applied to these BC preferences, all three SI options received more votes than equity and efficiency in the first round and consequently SI_1 and SI_3 emerged as the winner in LE-3 and LE-4, respectively. TRS yields very similar results.

Turning to the outcomes under STV for medium electorates, we find that ties are less frequent, probably due to the larger size of the electorates. Nevertheless, self-interest options still win an overwhelming amount of elections. In HOM-3 and HOM-4, equity only wins 11% and 20% of the elections, respectively, whereas efficiency never emerges as the winner. In HET-3 and HET-4, where the type distribution in the electorate is asymmetric, compromises tend to be selected more often than in HOM. However, they are still chosen less frequently than under PV.

Given that rank-order methods are often used in actual political elections as an alternative to Plurality Voting, these results are striking. However, the intuition is simple. Rank-Order methods as STV and TRS employ multiple rounds of ballot counting, with alternatives which fare poorly in one round being eliminated from the set available in the next round. Faring poorly, though, is defined as being ranked highest by a small share of the electorate. Under these methods, self-interest alternatives are almost universally ranked first in the first round, resulting in a small support for compromises. Hence, the latter are often eliminated and are simply not available in later rounds. By basing the elimination criterion on the highest-ranked alternatives, rank-order methods run into the same problem as PV: the information on which alternatives would be acceptable for a large share of the electorate is lost.

7 Discussion

Our results suggest that moving away from current voting systems and toward methods that give voters more flexible and detailed ways to express their preferences could greatly reduce the prevalence of extreme outcomes in actual elections. With these, more flexible voting methods in place (but not with the ones which are mostly used nowadays), two key, prominent social conventions, social justice (equity) and efficiency, can help polarized societies achieve desirable compromises.

In our experiments, which include both small electorates in the laboratory as well as medium and large electorates online, Plurality Voting (and also rank-order methods as Single Transferable Vote) generally exacerbates the results of egoistic voting, whereas both Approval Voting and Borda Count partially mitigate them, with large-magnitude effects on election outcomes. Inequality (as a result of implementing efficiency at the societal level) plays a large role. Efficiency losers, who get the short end of the stick when the efficient alternative is implemented, exhibit a higher degree of self-interest and are less sensible to the voting method. When both Efficiency and Equity are present, efficiency winners tend to favor Efficiency, whereas efficiency losers tend to favor Equity.

The choice of the method is also consequential. Borda Count tends to favor Equity over Efficiency independently of whether a majority or just a minority would benefit from Efficiency. Approval Voting is more reactive: It tends to implement Efficiency only if a majority of the society benefits from it, shifting to Equity otherwise. This suggests that Approval Voting might be more sensitive to and better reflect the aggregate preferences

of the electorate in contrast to the Borda Count, which might also affect other dimensions of voter satisfaction such as losers' consent.

In our experiments, we have concentrated on societies where several similarly-sized groups have opposed interests. We believe that this captures important features of polarized societies (Posner, 2004; Huber, 2012), for which our results might be especially relevant. If a dominant group were to constitute a majority with diametrally-opposed interests to the rest of the society, there is little hope that a compromise will be reached regardless of the voting method. However, as our asymmetric treatment with medium electorates shows, equal distributions are not a prerequisite for the results to be relevant. Indeed, we find that under PV an asymmetric electorate leads to even more extreme outcomes, whereas AV and BC allow the asymmetric electorate to successfully select socially desirable outcomes. For the latter two methods, the asymmetry only determines which but not whether a compromise is selected.

On the other hand, the problem in some societies might not be that the voting method prevents achieving a desirable compromise, but rather that a compromise is not available among the alternatives to begin with. In this latter case, there is little hope that changing the voting method will change the result in the short run. However, it is conceivable that the nonexistence of compromises might sometimes be a consequence of the expectation that, under existing voting methods, putting such options forward is fruitless, for instance because such attempts have been seen to fail in the past. Thus, changing the voting method might result in appropriate compromises arising.

Overall, our results suggest that some extreme outcomes in elections might partly be a consequence of the limitations of the voting methods currently in place, and not only of underlying social tendencies. If a faithful, descriptive representation of voters' preferences is among the main objectives of a voting method, then those based on Plurality Voting are doing a poor job of it. In doing so, they are also failing to provide clear majorities, identify stable social compromises, and ensure the legitimacy of the winners. Democratic societies might benefit from moving beyond currently-employed methods toward other, more nuanced ones capable of better eliciting preferences from voters and, especially, identifying acceptable social compromises. We have concentrated on two prominent methods, and found both to be an improvement over Plurality Voting and rank-order methods in this sense. A discussion can be started on the virtues of one or the other (or a third one), and our work already contributes to that. In terms of which social convention is favored, our data suggests that Approval Voting might be more responsive to the well-being of the majority, and seems to better elicit sincere voting behavior. However, choosing among methods should be viewed as a second-order consideration compared to the social urgency surrounding the potential negative consequences of rising extremism, and the fact that a purely methodological (legislative) change could greatly (and immediately) curtail them.

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Appendix A Medium (and Asymmetric) Electorates

We conducted an online experiment with medium electorates that varied the size of the three groups with different types of voters. In treatment HOM the electorate was symmetric (as in SE and ME), whereas in treatment HET the electorate was asymmetric. The treatments involved 1,620 voters each, for a total of 3,240 unique voters. We again focused on the payoff profiles of Societies 3 and 4.

In each treatment, voters were randomly assigned to electorates of 30 voters each. In HOM, we assigned 10 voters to each of the three possible types in each Society. In HET, the distribution of types was asymmetric. In Society 3 (HET-3), 8 voters were assigned to type 1, 9 to type 2, and 13 voters to type 3, increasing the size of the minority group of efficiency losers relative to HOM-3. This asymmetry between voter types in HET-3 affects the efficiency of alternatives in two ways: First, the three Self-Interest alternatives differ in terms of efficiency with SI_1 being the least and SI_3 the most efficient of those alternatives. Second, while Eff remains the efficient compromise in the sense of being more efficient than Equity, it is now less efficient overall compared to SI_3. In Society 4 (HET-4), 9 voters were assigned to type 1, 8 to type 2, and 13 to type 3, increasing the size of the minority group of efficiency winners relative to HOM-4. As in HET-3, the three Self-Interest options now differ in terms of efficiency, but now SI_1 is the most and SI_2 is the least efficient of those alternatives. In contrast to Society 3, however, Eff remains the alternative with the highest efficiency overall. Implementation was as in the laboratory, with the exception that each voter was assigned to a fixed type.

We first consider HOM, where electorates were symmetric. Figure A.1A details the payoffs and induced preferences in Society 3 for HOM. Figure A.1B summarizes actual aggregate voting behavior. EWs tend to support Efficiency (PV: 21.9%; AV: 31.1%; BC: 27.3%) over Equity (PV: 5.7%; AV: 11.8%; BC: 21.2%; PV, $p = 0.005$; AV and BC, $p < 0.001$). For ELs, support for Efficiency is virtually nonexistent (PV: 4.8%; AV: 6.5%; BC: 9.9%), and far smaller than their support for Equity (PV: 25.0%; AV: 30.9%; BC: 26.6%; all three methods $p < 0.001$). However, for all methods, Self-Interest options receive a larger support than Efficiency for EWs (all three methods $p < 0.001$), although the difference is small for AV and BC. Self-Interest options also receive a clearly larger support than Equity for ELs (all three methods $p < 0.001$).

Those differences in voting behavior result in considerable differences in voting outcomes (Fig. A.1C). Under PV, SI options win most of the time (66.0%), while under AV the most-frequent winner is Efficiency (51.9%) and under BC the most frequent winner is Equity (76.9%). Efficiency wins most frequently under AV, compared to both PV and BC (WSR tests, $N = 54$; both $p < 0.001$), and Equity wins most elections under BC (BC vs. PV, $p < 0.001$; BC vs. AV, $p = 0.002$). Equity still fares significantly better under AV than under PV ($p = 0.008$). Indeed, under AV SI options only win 1.9% of the elections, and only 2.8% under BC. That is, while Self-Interest often wins the upper hand under PV, each of the alternative voting methods manages to select a desirable

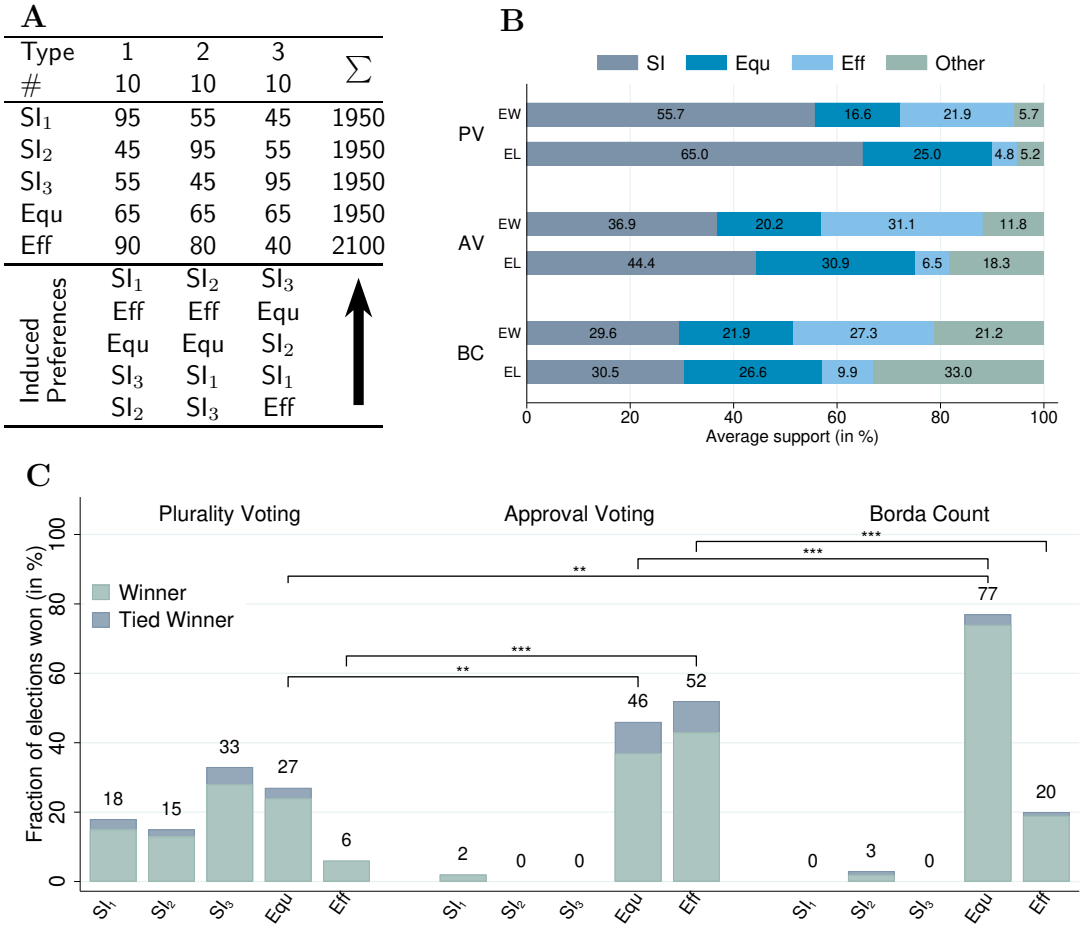


Figure A.1: Preferences, voting behavior, and outcomes for HOM-3.

Notes: **A**, Voter preferences per electorate, induced monetarily. **B**, Aggregate voting behavior for the 1,620 voters. **C**, Voting outcomes for the 54 electorates, by voting method. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

social convention as an acceptable compromise, which goes on to win most elections. The methods clearly differ, with AV favoring Efficiency and BC selecting Equity.

We now turn to Society 4 in HOM. Payoffs and induced preferences are shown in Fig. A.2A). Figure A.2B summarizes actual aggregate voting behavior for Society 4. EWs tend to support Equity over Efficiency under PV (Equ 21.7%, Eff 14.1%, $p = 0.003$), whereas they tend to support Efficiency over Equity under AV (Equ 20.8%, Eff 30.0%, $p < 0.001$) and BC (Equ 22.6%, Eff 26.4%, $p < 0.001$). For ELs, support for Efficiency (PV: 4.0%; AV: 13.3%; BC: 20.4%) is much smaller than support for Equity (PV: 25.0%; AV: 30.7%; BC: 27.0%; all three methods $p < 0.001$). For EWs, Self-Interest options receive a larger support than Equity under PV ($p < 0.001$) and also a larger support than Efficiency under AV and BC (both methods $p < 0.001$), although the difference is small for AV and BC. Self-Interest options receive a clearly larger support than Equity for ELs (all three methods $p < 0.001$).

A

Type	1	2	3	$\sum$
#	10	10	10	
SI_1	95	55	45	1950
SI_2	45	95	55	1950
SI_3	55	45	95	1950
Equ	65	65	65	1950
Eff	62	58	90	2100
Induced Preferences	SI_1	SI_2	SI_3	
	Equ	Equ	Eff	
	Eff	Eff	Equ	
	SI_3	SI_1	SI_2	
	SI_2	SI_3	SI_1	

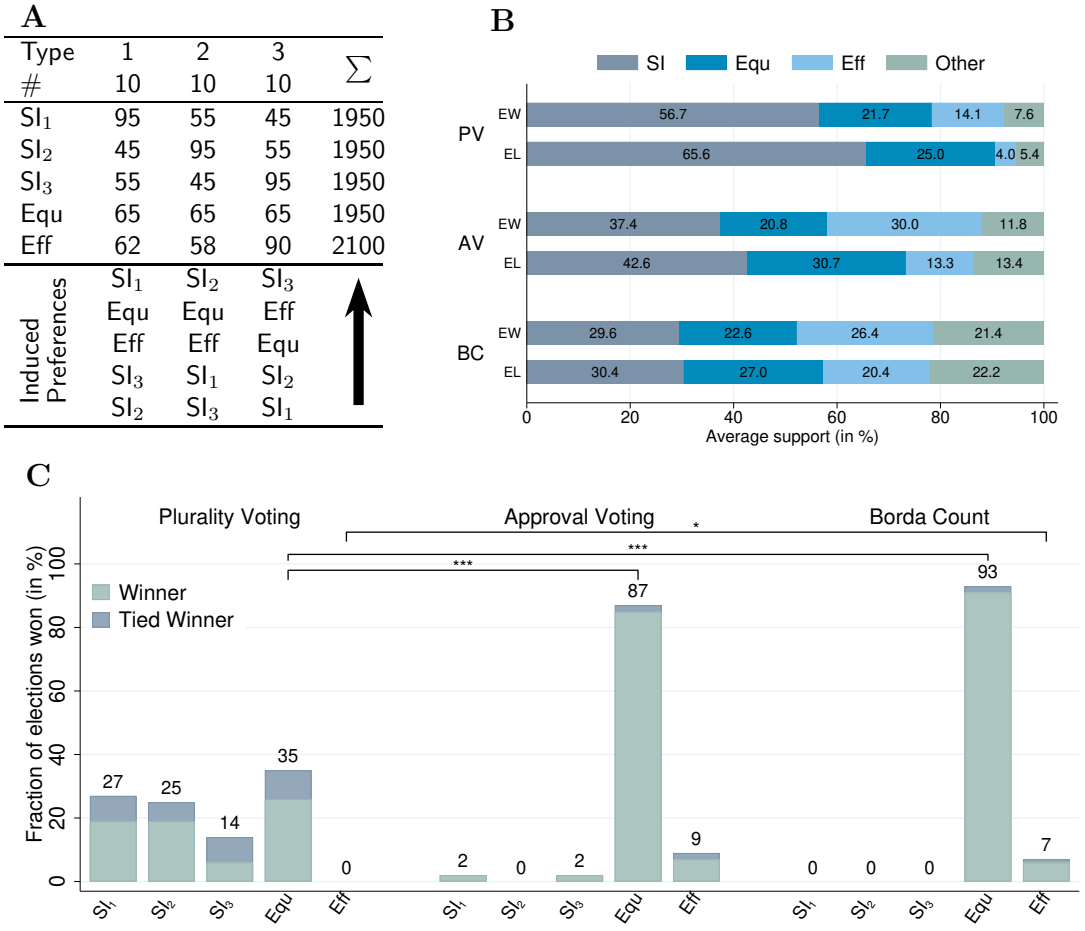


Figure A.2: Preferences, voting behavior, and outcomes for HOM-4.

Notes: **A**, Voter preferences per electorate, induced monetarily. **B**, Aggregate voting behavior for the 1,620 voters. **C**, Voting outcomes for the 54 electorates, by voting method. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Under PV, the average support received by Efficiency from EWs is almost cut in half in Society 4 (where efficiency benefits only a few) compared to Society 3 (where efficiency benefits a majority). That is, we again observe a clear "wasted vote" effect for EWs under PV when they are in the minority. This effect is absent under AV (Soc. 3: 31.1%, Soc. 4: 30.0%) and BC (Soc. 3: 27.3%, Soc. 4: 26.4%). For ELs, support for Self-Interest and Equity are very similar in Societies 3 and 4. However, Efficiency also receives some support from ELs under AV (13.3%) and BC (20.4%) in Society 4, as observed previously for small electorates.

Differences in voting outcomes are also large for Society 4 (Fig. A.2C). Under PV, SI options win an overwhelming 65.1% of the time. In contrast, under both AV and BC Equity emerges as the winner in almost all elections (AV, 87.0%; BC, 92.6%), and both select it significantly more often than PV ($N = 54$; both $p < 0.001$). Since PV never selects Efficiency, it also is selected (marginally) more often under AV ($p = 0.051$) and BC ($p = 0.043$). There is no significant difference in outcomes between AV and BC. In

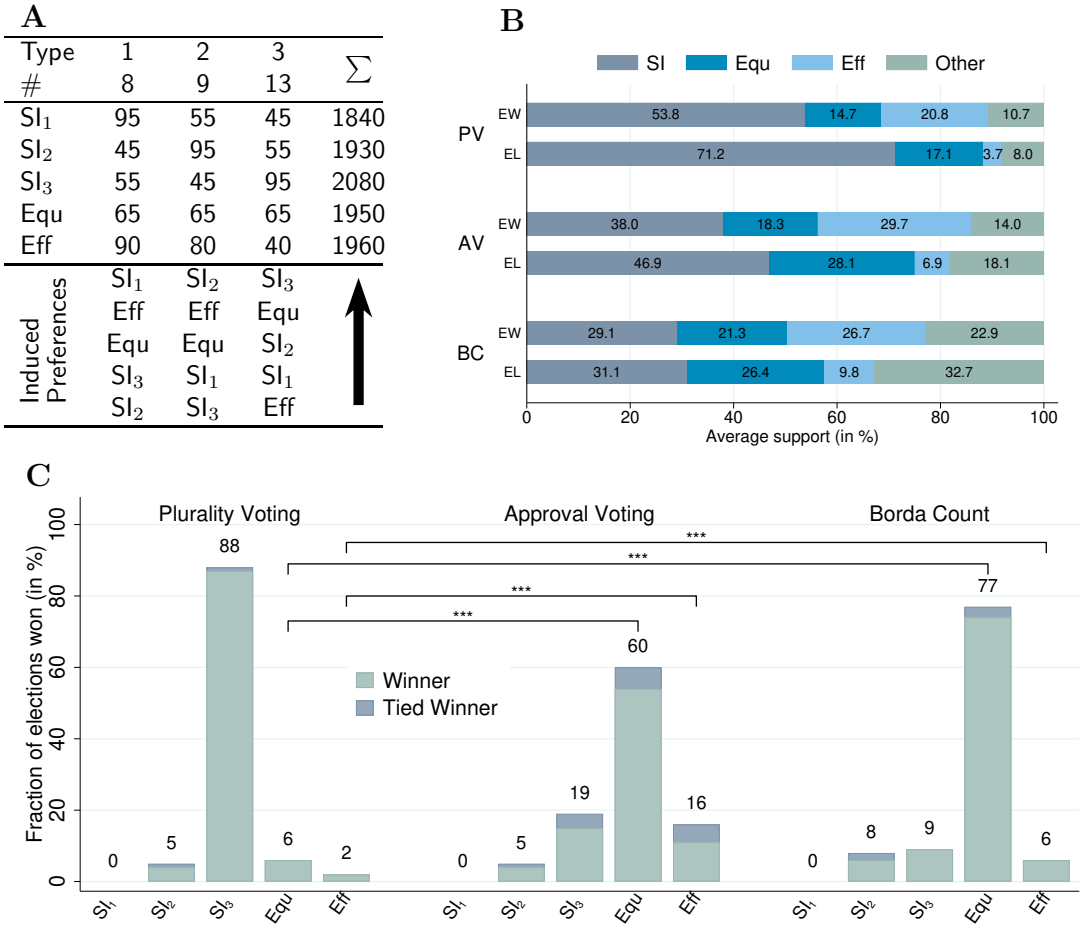


Figure A.3: Preferences, voting behavior, and voting outcomes for HET-3.

Notes: **A**, Voter preferences per electorate, induced monetarily. **B**, Aggregate voting behavior for the 1,620 voters. **C**, Voting outcomes for the 54 electorates, by voting method. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

summary, HOM confirms the results on voting outcomes obtained previously for small electorates.

Next, we turn to HET, where electorates were asymmetric. Figure A.3A details the payoffs and induced preferences in Society 3 for HET. Figure A.3B summarizes actual aggregate voting behavior. EWs tend to support Efficiency (PV: 20.8%; AV: 29.7%; BC: 26.4%) over Equity (PV: 14.7%; AV: 18.3%; BC: 21.3%; $N = 918$, PV, $p = 0.002$; AV and BC, $p < 0.001$). For ELs, support for Efficiency is virtually nonexistent (PV: 3.7%; AV: 6.9%; BC: 9.8%), and far smaller than their support for Equity (PV: 17.1%; AV: 28.1%; BC: 26.4%; $N = 702$, all three methods $p < 0.001$). However, for all methods, Self-Interest options receive a larger support than Efficiency for EWs (all three methods $p < 0.001$), although the difference is small for AV and BC. Self-Interest options also receive a clearly larger support than Equity for ELs (all three methods $p < 0.001$).

Those differences in voting behavior result in considerable differences in voting outcomes (Fig. A.3C). Under PV, SI options win almost all elections (92.6%), while under

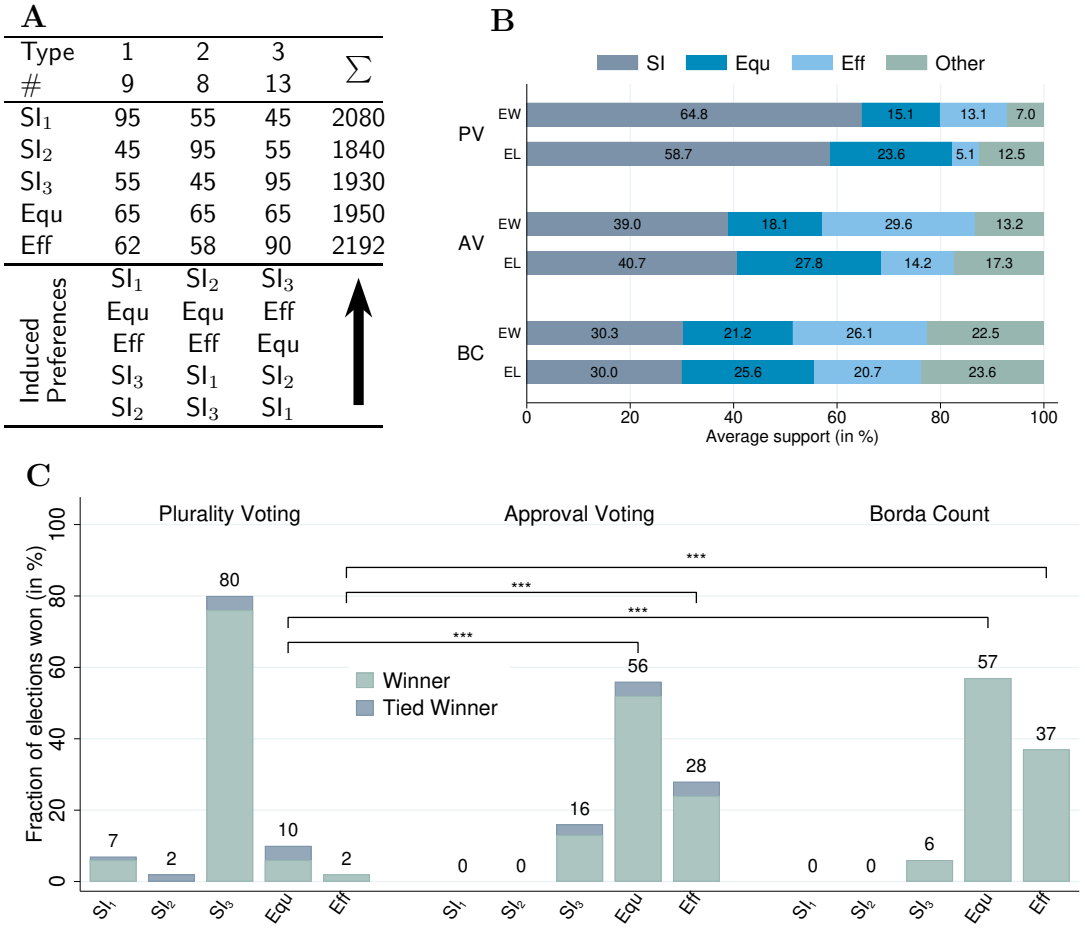


Figure A.4: Preferences, voting behavior, and voting outcomes for HET-4.

Notes: **A**, Voter preferences per electorate, induced monetarily. **B**, Aggregate voting behavior for the 1,620 voters. **C**, Voting outcomes for the 54 electorates, by voting method. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

AV and BC the most-frequent winner is Equity (AV: 60.2%; BC: 76.9%). Efficiency wins more frequently under AV compared to both PV and BC (WSR tests, $N = 54$: AV vs. PV $p = 0.013$; AV vs. BC $p = 0.049$), and Equity wins most elections under AV and BC (BC vs. PV, $p < 0.001$; AV vs. PV, $p < 0.001$) with no significant difference between AV and BC ($p = 0.066$). Under AV SI options win 24.1% of the elections, and 17.6% under BC. That is, while Self-Interest almost always wins the upper hand under PV, each of the alternative voting methods manages to select a desirable social convention as an acceptable compromise, which goes on to win most elections. In contrast to HOM, here both AV and BC select Equity.

Finally, we consider Society 4 in HET. Payoffs and induced preferences are shown in Fig. A.4A). Figure A.4B summarizes actual aggregate voting behavior for Society 4. For EWs, there is no difference in support between Equity and Efficiency under PV (Equ 15.1%, Eff 13.1%, $p = 0.320$), whereas EWs tend to support Efficiency over Equity under AV (Equ 18.1%, Eff 29.6%, $p < 0.001$) and BC (Equ 21.2%, Eff 26.1%, $p < 0.001$). For

ELs, support for Efficiency (PV: 5.1%; AV: 14.2%; BC: 20.7%) is much smaller than support for Equity (PV: 23.6%; AV: 27.8%; BC: 25.6%; all three methods $p < 0.001$). For EWs, Self-Interest options receive a larger support than Equity under PV ($p < 0.001$) and also a larger support than Efficiency under AV and BC (both methods $p < 0.001$), although the difference is small for AV and BC. Self-Interest options receive a clearly larger support than Equity for ELs (all three methods $p < 0.001$).

Under PV, the average support received by Efficiency from EWs is almost cut in half in Society 4 (where efficiency benefits only a few) compared to Society 3 (where efficiency benefits a majority). That is, we again observe a clear "wasted vote" effect for EWs under PV when they are in the minority. This effect is absent under AV (Soc. 3: 29.7%, Soc. 4: 29.6%) and BC (Soc. 3: 26.7%, Soc. 4: 26.1%). For ELs, support for Self-Interest and Equity are very similar in Societies 3 and 4. However, again Efficiency receives some support from ELs under AV (14.2%) and BC (20.7%) in Society 4.

Differences in voting outcomes are also large for Society 4 in HET (Fig. A.4C). Under PV, SI options win an overwhelming 88.6% of the time. In contrast, under both AV and BC Equity emerges as the winner most of the time (AV, 56.5%; BC, 57.4%), and both select it significantly more often than PV ($N = 54$; both $p < 0.001$). Since PV almost never selects Efficiency, it is also selected more often under AV and BC (both $p < 0.001$). There is no significant difference in outcomes between AV and BC. In summary, also HET confirms the results on voting outcomes obtained previously for small electorates.

Appendix B Sincerity (Medium Electorates)

Fig. A.5 displays the fraction of sincere votes in our Large Electorates, for each voting method (see discussion in the main text). Fig. A.6 shows that, as in the case of Small Electorates, for Medium Electorates a sizable fraction of voters prefers (according to elicited preferences) one of the social conventions, Equity (20-22%) or Efficiency (16-19%), to implementing their payoff-maximizing alternative.

We report now on the details of elicited sincerity for Medium Electorates. We find a large fraction of insincere votes under PV, except for efficiency losers in HET-3 (Fig. A.7). In contrast, we find high levels of sincerity under AV and no systematic difference in sincerity between EWs and ELs except for HET-3 (MWU tests, $N = 1620$; HOM-3, $p = 0.369$; HOM-4, $p = 0.232$; HET-3, $p = 0.016$; HET-4, $p = 0.117$;). Under BC there is also a large fraction of insincere votes, with no difference in strategic voting between EWs and ELs for HOM (HOM-3, $p = 0.273$; HOM-4, $p = 0.359$). However, in HET there is a stronger tendency toward strategic voting for EWs compared to ELs in Society 3 (HET-3, $p = 0.003$), whereas we find the opposite for Society 4 (HET-4, $p < 0.001$).

Comparing elicited sincerity to induced sincerity, we find that sincerity tends to be higher with respect to the elicited preferences compared to the induced preferences for PV (5 out of 8 tests significant). For AV, we find that the overall level of sincerity is qualitatively the same with respect to both the induced and the elicited preferences

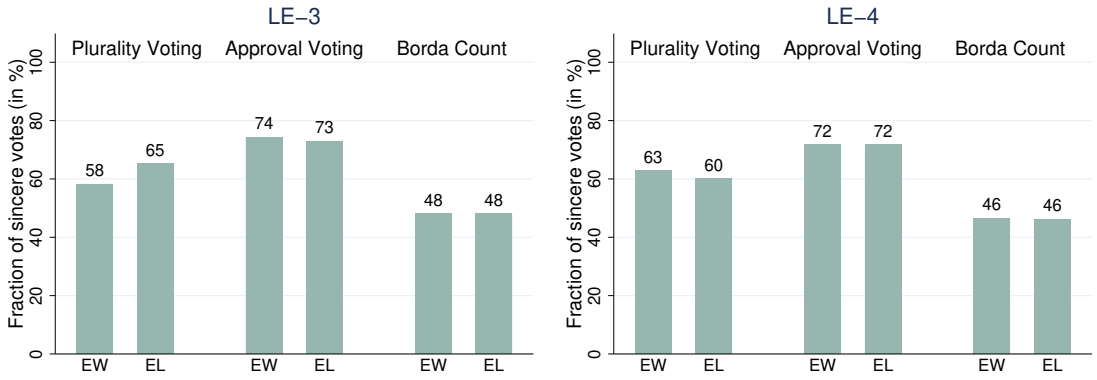


Figure A.5: Induced sincere votes for large electorates.
Notes: Fraction of induced sincere votes for each voting method for large electorates.

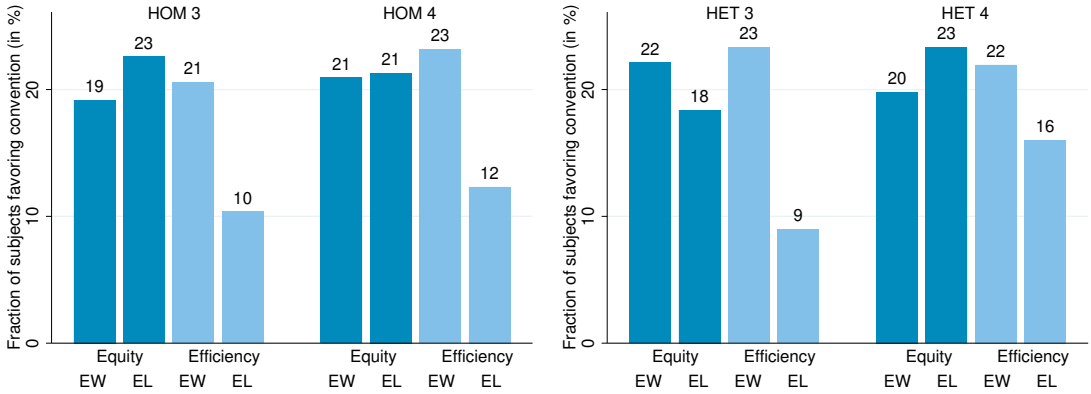


Figure A.6: Elicited preferences in medium electorates.
Notes: Fraction of subjects who favor Equity or Efficiency over Self-Interest at least once, according to their elicited preferences.

(7 out of 8 tests are insignificant). For BC, induced sincerity tends to be higher than elicited sincerity (6 out of 8 tests significant).

Appendix C Consistency

Behavior for PV is *consistent* with AV if the alternative voted for under PV is contained in the set of approved alternatives under AV, and *consistent* with BC if the alternative voted for under PV is the top-ranked alternative under BC. AV is *consistent* with BC if the AV set is a top segment in the BC ranking. We find a high consistency between PV and AV for all four societies SE (86–92%; Fig. A.8), and also for both societies in LE (LE-3: 86.9%, LE-4 83.6%, Fig. A.9; HOM-3: 85.6%, HOM-4: 87.7%, HET-3:85.2%, HET-4:84.8%, Fig. A.10). That is, the PV vote is mostly contained in the approval set under AV for both EWs and ELs. Consistency of PV with BC is systematically lower than consistency of AV with BC in SE (WSR tests, $N = 180$; Soc. 1, $p = 0.091$; Soc.

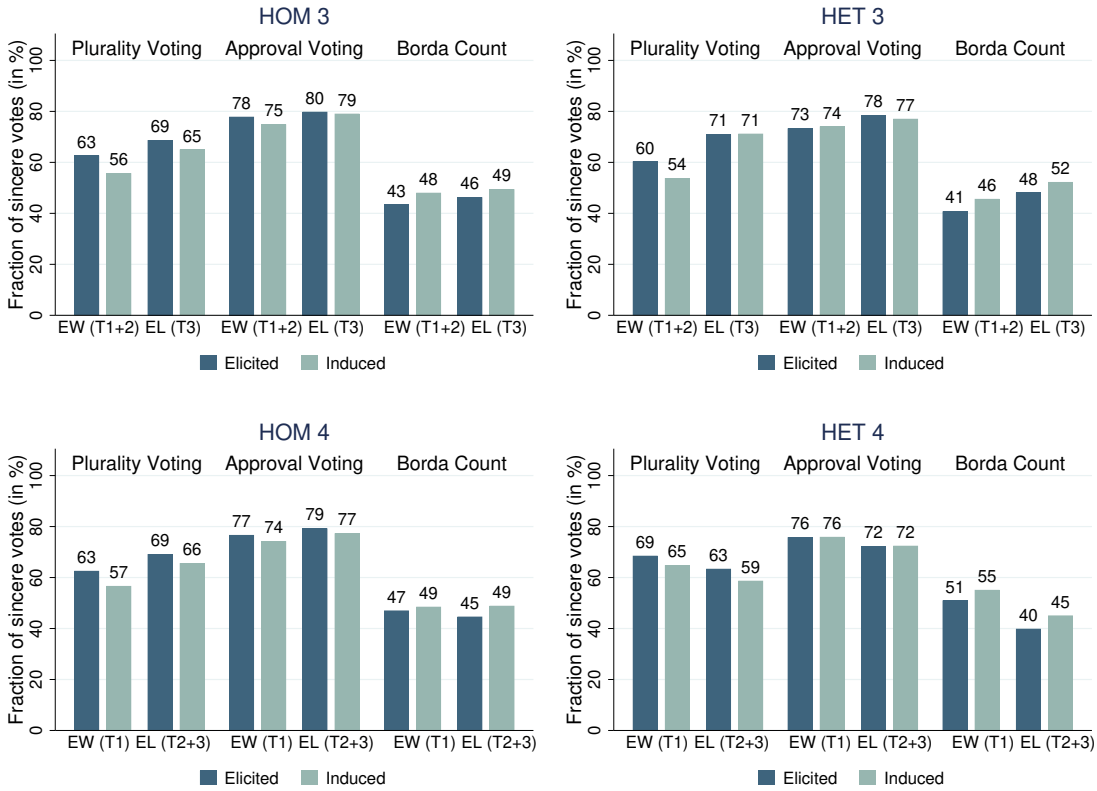


Figure A.7: Induced and elicited sincere votes.

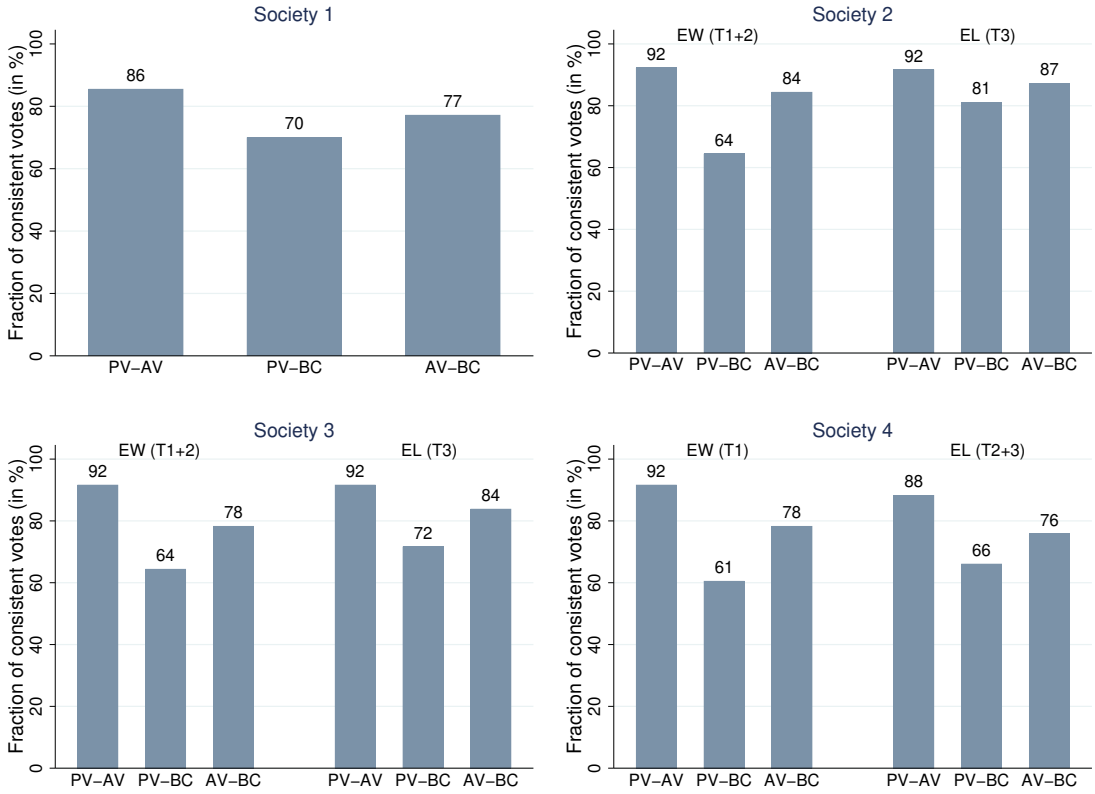
Notes: Fraction of induced/elicited sincere votes for each voting method for medium electorates.

2–4, all $p < 0.001$), in LE with the exception of ELs in LE-3 (EWs: LE-3, $N = 800$, $p < 0.001$; LE-4, $N = 400$, $p = 0.002$; ELs: LE-3, $N = 400$, $p = 0.254$; LE-4, $N = 800$, $p = 0.003$), and in ME with the exception of ELs in HET-3 (EWs: HOM-3, $N = 1080$, $p < 0.001$; HOM-4, $N = 540$, $p < 0.001$; HET-3, $N = 918$, $p < 0.001$; HET-4, $N = 702$, $p < 0.001$; ELs: HOM-3, $N = 540$, $p < 0.001$; HOM-4, $N = 1080$, $p < 0.001$; HET-3, $N = 702$, $p = 0.134$; HET-4, $N = 918$, $p < 0.001$). We also observe that, for EWs, consistency is lowest between PV and BC (61–64% in SE; 56.5–60.0% in LE; 61–64% in ME), possibly indicating that EWs are particularly prone to strategic behavior under BC.

Appendix D Legitimacy of the Winner

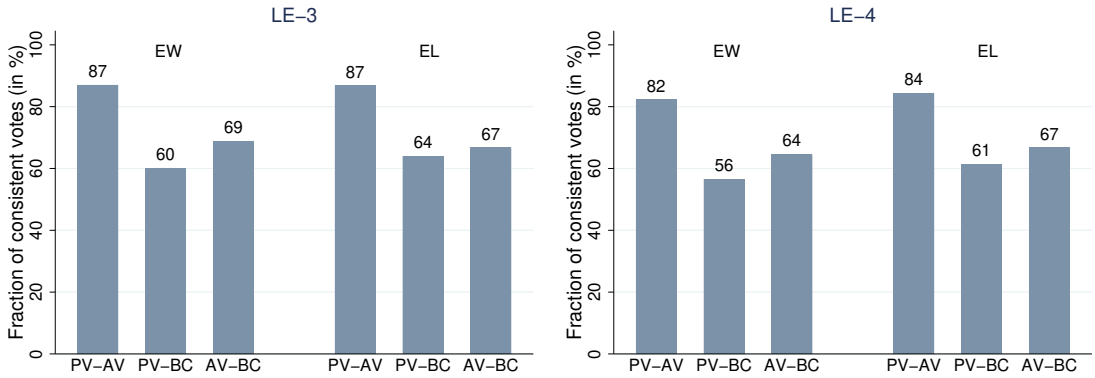
The recognition of the legitimacy of the winner in an electoral system is crucial for stable governments or resolutions (Nadeau and Blais, 1993; Anderson and Mendes, 2006). Thus, besides the question of which alternative is selected by a voting method in a given environment, it is also important to study the legitimacy of the winner. For a given voting method, we define legitimacy of an alternative as the average proportion of votes/approvals/points of the alternative, conditional on being the winner, relative

Figure A.8: Consistency for small electorates.



Note: Consistency of voting behavior across voting methods. PV is consistent with AV if the alternative voted for under PV is also approved of under AV. PV is consistent with BC if the alternative voted for under PV is the top-ranked alternative under BC. AV is consistent with BC if the approval set is a top segment in the ranking under BC.

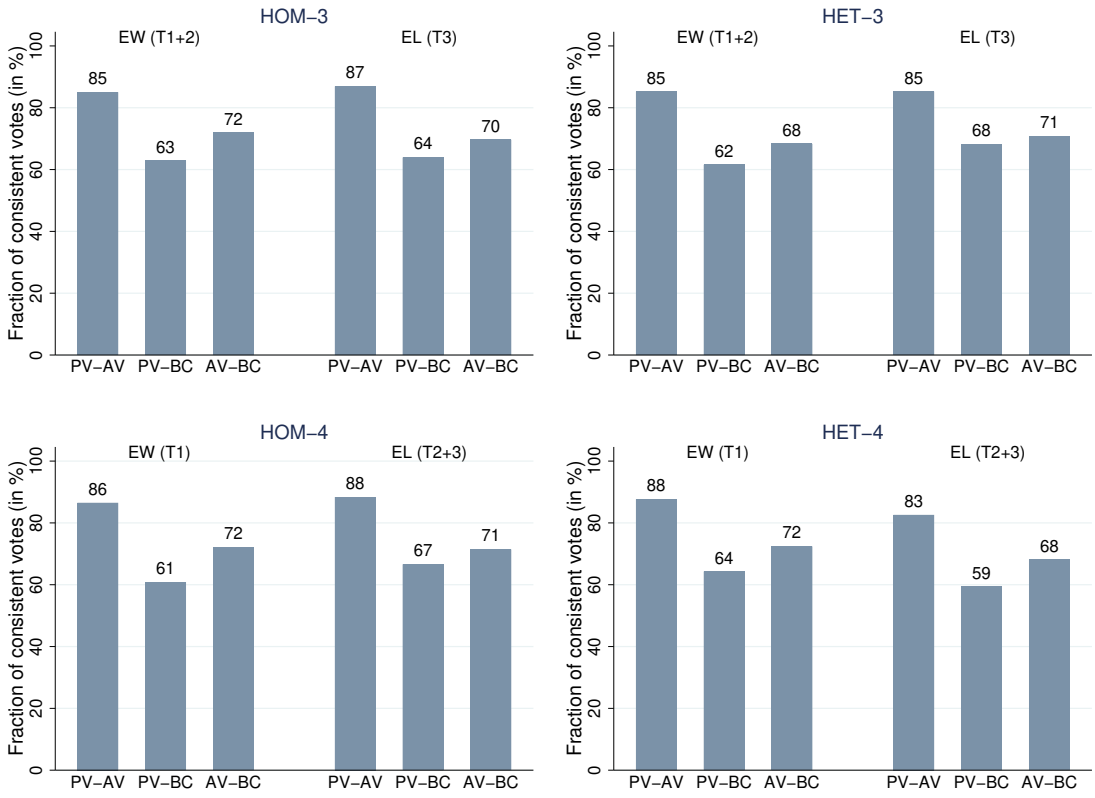
Figure A.9: Consistency in large electorates.



Note: Consistency of voting behavior across voting methods for LE-3 and LE-4. PV is consistent with AV if the alternative voted for under PV is also approved of under AV. PV is consistent with BC if the alternative voted for under PV is the top-ranked alternative under BC. AV is consistent with BC if the approval set is a top segment in the ranking under BC.

to the maximum number of votes/approvals/points an alternative can obtain. That is, legitimacy of an alternative is 0% if no voter voted for/approved of that alternative or if

Figure A.10: Consistency in medium electorates.



Note: Consistency of voting behavior across voting methods for medium electorates. PV is consistent with AV if the alternative voted for under PV is also approved of under AV. PV is consistent with BC if the alternative voted for under PV is the top-ranked alternative under BC. AV is consistent with BC if the approval set is a top segment in the ranking under BC.

all voters ranked it last. Conversely, legitimacy is 100% if all voters voted for/approved of that alternative or if all voters ranked it first.

To compare legitimacy, we focus on the most-frequent winner for each society and experiment/treatment summarized in Table A.1. There are two important insights: First, legitimacy is smaller the larger the electorate for all voting methods. Average legitimacy across treatments in SE is highest, with 40.1% for PV, 68.0% for AV, and 66.8% for BC. In comparison, for the medium electorates legitimacy drops to 32.7% for PV, 63.0% for AV, and 61.5% for BC. Legitimacy is lowest for large electorates amounting to 24.4% for PV, 59.1% for AV, and 59.1% for BC. Second, legitimacy is low for PV, whereas it is high for both AV and BC. For PV, legitimacy ranges from 24.8% to 44.4% across treatments and experiments, in particular, the legitimacy of the most-frequent winner is always well below 50%. In contrast, for AV and BC legitimacy ranges from 57.7% to 75.0% and from 58.0% to 71.8%, respectively. That is, in all treatments legitimacy of the most-frequent winner is well above 50% for both AV and BC.[9]

[9]In the first municipal election under AV in Fargo, North Dakota, in June 2020, both of the elected candidates received more than 50% approvals by voters. In the last municipal elections before the introduction of AV in St. Louis, Missouri, the winner received only 32% of the vote; in contrast, in

Table A.1: Legitimacy of the winner (in percent).

			Most frequent winner (Legitimacy)		
			PV	AV	BC
SE		Soc. 1	Equ (44.4)	Equ (75.0)	Equ (71.8)
		Soc. 2	Eff (40.5)	Eff (65.8)	Eff (61.1)
		Soc. 3	Eff (38.7)	Eff (61.6)	Equ (63.8)
		Soc. 4	SI_1 (36.8)	Equ (69.6)	Equ (70.5)
ME	HOM	Soc. 3	SI_3 (29.4)	Eff (59.9)	Equ (59.9)
		Soc. 4	Equ (30.8)	Equ (67.6)	Equ (64.3)
	HET	Soc. 3	SI_3 (36.2)	Equ (61.0)	Equ (59.9)
		Soc. 4	SI_3 (34.3)	Equ (63.4)	Equ (61.8)
LE		Soc. 3	SI_3 (24.0)	Eff (57.7)	Equ (58.0)
		Soc. 4	SI_3 (24.8)	Equ (60.4)	Equ (60.2)

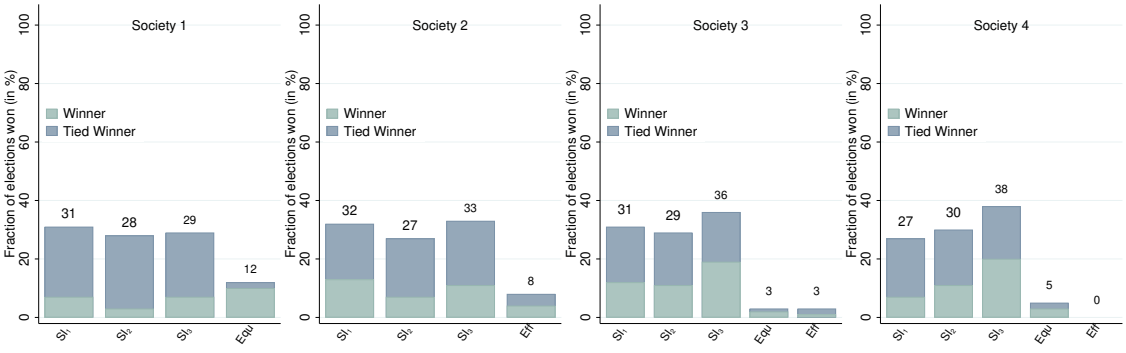


Figure A.11: Voting outcomes under single transferable vote for small electorates.
Notes: Actual voting outcomes for the 30 small electorates under single transferable vote based on subjects elicited preferences with ties split randomly.

Appendix E Rank-Order Methods

Extrapolation based on elicited preference ranking

In this section, we use the preference rankings elicited via the random dictator mechanism to infer the outcomes that would be obtained under other voting procedures by extrapolation based on their elicited preference (an analogous analysis based on the ranking elicited under BC delivers similar results). Specifically, we will consider the rank-order method Single Transferable Vote (STV) and the two-round system (TRS) used in the French presidential elections.

Under STV, there are multiple rounds of ballot counts. In the first round, only the alternatives that are ranked first are counted. If an alternative receives an absolute majority, it is declared the winner. Otherwise, the alternatives that are ranked first by the fewest voters are eliminated from all the ballots. In the second round, only the

March 2021, under AV, the winner received 57% of approvals (and became the city's first Black woman mayor) (Alley Peña, 2021).

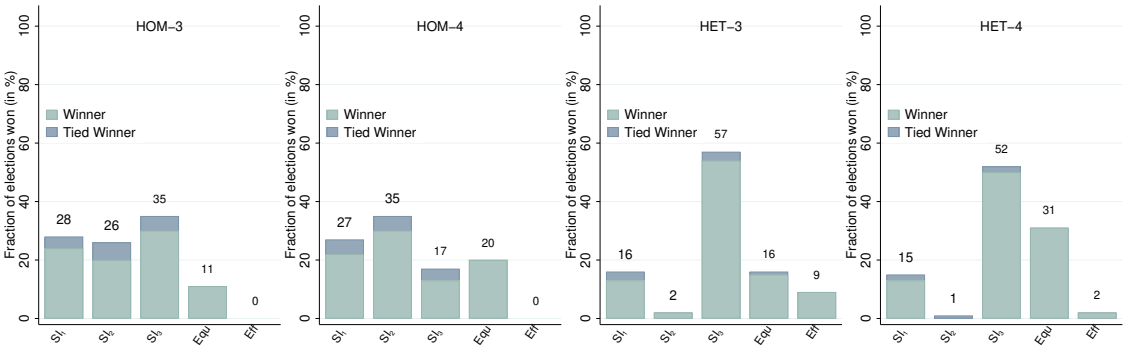


Figure A.12: Voting outcomes under single transferable vote for HOM and HET.
Notes: Actual voting outcomes for the 30 small electorates under single transferable vote based on subjects elicited preferences with ties split randomly.

alternatives that are now (after elimination) ranked first are counted. If an alternative receives an absolute majority, it is declared the winner. This procedure is repeated until there is an alternative that receives an absolute majority or several alternatives are tied with the highest proportion of votes. Ties are broken randomly.

Figure A.11 shows the induced election outcomes for small electorates under STV. Voting outcomes exhibit a large number of ties, with self-interest options winning an overwhelming amount of elections. In Society 1, equity wins only 12% of the elections with the remaining elections going to self-interest alternatives. In Society 2, efficiency performs even worse, winning only 8% of the elections. In Society 3, the outcomes almost always go in favor of self-interested options with each of equity and efficiency winning only 3% of the elections. In Society 4, efficiency never emerges as the winner, whereas equity wins a meager 5% of the elections. Summarizing, our analysis suggests that outcomes under STV (assuming that voters vote according to their elicited preferences) would be even more extreme than under PV.

Figure A.12 shows the induced election outcomes for medium electorates (HOM and HET) under STV. Electorates are larger than in SE and, hence, ties are much less frequent. Nevertheless, self-interest options still win an overwhelming amount of elections. In HOM-3, the outcomes almost always go in favor of self-interested options with equity winning only 11% of the elections and efficiency not winning a single one. In HOM-4 the picture is not much different: again efficiency never emerges as the winner, whereas equity wins 20% of the elections. In HET-3, the self-interest options favoring the largest group of voters wins most elections with equity and efficiency winning only 16% and 9% of the elections, respectively. A similar picture emerges for HET-4, here, however, equity wins 31% of the elections, whereas efficiency wins almost no elections (2%). Thus, in HET, where the type distribution in the electorate is asymmetric, compromises tend to be selected more often than in HOM.

Summarizing, our results suggest that the outcomes under STV (assuming that voters vote according to their elicited preferences) would be even more extreme than under PV.

Under the two-round system (TRS), voters participate in two rounds of plurality voting. The two candidates that receive the most votes in the first round participate in a second runoff plurality vote. The candidate that receives the majority of votes in the second round is declared the winner. For small electorates, the voting outcomes under TRS turn out to be exactly the same as the ones obtained under STV, presented in Figure A.11. For medium electorates (HOM and HET), equity and efficiency win even slightly less often but otherwise the results are also very similar to those under STV presented in Figure A.12.

Extrapolation based on Borda Count ranking

In this section, we apply the procedure outlined in the previous section to the ranking elicited under BC to infer the outcomes under STV and TRS. This allows us to apply the same procedure also to the large electorate experiment where the preference elicitation via the random dictator mechanism was not included.

For LE-3, in the first round of STV the three self-interest options were ranked first by 280, 284, and 295 voters respectively, whereas equity received 141 votes and efficiency received 200 votes. Consequently, equity is eliminated in the first round. In the second round, the three self-interest options receive 297, 309, and 338 votes, respectively, whereas efficiency is ranked first by 256 voters. Hence, efficiency is eliminated in the second round, and completing the procedure SI_1 emerges as the winner. For LE-4, in the first round of STV the three self-interest options were ranked first by 289, 306, and 317 voters respectively, whereas equity received 152 votes and efficiency received 136 votes. Consequently, efficiency is eliminated first. In the second round, the three self-interest options receive 318, 324, and 347 votes, respectively, whereas equity is ranked first by 211 voters. Hence, equity is eliminated in the second round, and completing the procedure SI_3 emerges as the winner.

Next, we consider the two-round system (TRS). For LE-3, in the first round of TRS the three self-interest options were ranked first by 280, 284, and 295 voters, respectively, whereas equity received 141 votes and efficiency received 200 votes. Consequently, SI_2 and SI_3 participate in the runoff. In the second round, SI_3 wins with 702 to 498 votes. For LE-4, a very similar picture emerges. Again SI_2 and SI_3 participate in the second round runoff, and again SI_3 emerges as the winner with 710 to 490 votes.

Appendix F Predicted Outcomes

In this section, we provide the predicted outcomes assuming voters vote sincerely according to their induced preferences. Figures A.13 and A.14 summarize the results of sincere voting for Societies 1–4 in SE. The predictions for LE and treatment HOM of ME are identical. Figure A.15 summarizes the results of sincere voting for Societies 3 and 4 in treatment HET of ME.

Society 1				
Type	1	2	3	
#	2	2	2	
Induced Preferences	SI_1	SI_2	SI_3	↑
	Equ	Equ	Equ	
	SI_3	SI_1	SI_2	
	SI_2	SI_3	SI_1	
		PV		Votes
SI_1	2	0	0	2
SI_2	0	2	0	2
SI_3	0	0	2	2
Equ	0	0	0	0
		AV_2		
SI_1	2	0	0	2
SI_2	0	2	0	2
SI_3	0	0	2	2
Equ	2	2	2	6
		AV_3		
SI_1	2	2	0	4
SI_2	0	2	2	4
SI_3	2	0	2	4
Equ	2	2	2	6
		BC		
SI_1	6	2	0	8
SI_2	0	6	2	8
SI_3	2	0	6	8
Equ	4	4	4	12

Society 2				
Type	1	2	3	
#	2	2	2	
Induced Preferences	SI_1	SI_2	SI_3	↑
	Eff	Eff	SI_2	
	SI_3	SI_1	SI_1	
	SI_2	SI_3	Eff	
		PV		Votes
SI_1	2	0	0	2
SI_2	0	2	0	2
SI_3	0	0	2	2
Eff	0	0	0	0
		AV_2		
SI_1	2	0	0	2
SI_2	0	2	2	4
SI_3	0	0	1	1
Eff	2	2	0	4
		AV_3		
SI_1	2	2	2	6
SI_2	0	2	2	4
SI_3	2	0	2	4
Eff	2	2	0	4
		BC		
SI_1	6	2	2	10
SI_2	0	6	4	10
SI_3	2	0	6	8
Eff	4	4	0	8

Figure A.13: Predicted outcomes under sincere voting for Societies 1 and 2 in small electorates.

Note: Outcomes are calculated under the assumption that subjects vote sincerely according to their induced preferences. AV_2 assumes that all voters approve of exactly two alternatives. AV_3 assumes that all voters approve of exactly three alternatives. Predicted winners are highlighted in boldface.

Society 3				
Type	1	2	3	
#	2	2	2	
Induced Preferences	SI_1	SI_2	SI_3	↑
	Eff	Eff	Equ	
	Equ	Equ	SI_2	
	SI_3	SI_1	SI_1	
	SI_2	SI_3	Eff	
		PV		Votes
SI_1	2	0	0	2
SI_2	0	2	0	2
SI_3	0	0	2	2
Equ	0	0	0	0
Eff	0	0	0	0
		AV_2		
SI_1	2	0	0	2
SI_2	0	2	0	2
SI_3	0	0	2	2
Equ	0	0	2	2
Eff	2	2	0	4
		AV_3		
SI_1	2	0	0	2
SI_2	0	2	2	4
SI_3	0	0	2	2
Equ	2	2	2	6
Eff	2	2	0	4
		BC		
SI_1	8	2	2	12
SI_2	0	8	4	12
SI_3	2	0	8	10
Equ	4	4	6	14
Eff	6	6	0	12

Society 4				
Type	1	2	3	
#	2	2	2	
Induced Preferences	SI_1	SI_2	SI_3	↑
	Eff	Equ	Equ	
	Equ	Eff	Eff	
	SI_3	SI_1	SI_2	
	SI_2	SI_3	SI_1	
		PV		Votes
SI_1	2	0	0	2
SI_2	0	2	0	2
SI_3	0	0	2	2
Equ	0	0	0	0
Eff	0	0	0	0
		AV_2		
SI_1	2	0	0	2
SI_2	0	2	0	2
SI_3	0	0	2	2
Equ	0	2	2	4
Eff	2	0	0	2
		AV_3		
SI_1	2	0	0	2
SI_2	0	2	0	2
SI_3	0	0	2	2
Equ	2	2	2	6
Eff	2	2	2	6
		BC		
SI_1	8	2	0	10
SI_2	0	8	2	10
SI_3	2	0	8	10
Equ	4	6	6	16
Eff	6	4	4	14

Figure A.14: Predicted outcomes under sincere voting for Societies 3 and 4 in small electorates.

Note: Outcomes are calculated under the assumption that subjects vote sincerely according to their induced preferences. AV_2 assumes that all voters approve of exactly two alternatives. AV_3 assumes that all voters approve of exactly three alternatives. Predicted winners are highlighted in boldface.

Society 3				
Type	1	2	3	
#	8	9	13	
Induced Preferences	SI_1 Eff Equ SI_3 SI_2	SI_2 Eff Equ SI_1 SI_3	SI_3 Equ SI_2 SI_1 Eff	↑
		PV		Votes
SI_1	8	0	0	8
SI_2	0	9	0	9
SI_3	0	0	13	13
Equ	0	0	0	0
Eff	0	0	0	0
		AV_2		
SI_1	8	0	0	8
SI_2	0	9	0	9
SI_3	0	0	13	13
Equ	0	0	13	13
Eff	8	9	0	17
		AV_3		
SI_1	8	0	0	8
SI_2	0	9	13	22
SI_3	0	0	13	13
Equ	8	9	13	30
Eff	8	9	0	17
		BC		
SI_1	32	9	13	41
SI_2	0	36	26	62
SI_3	8	0	52	60
Equ	16	18	39	73
Eff	24	27	0	51

Society 4				
Type	1	2	3	
#	13	9	8	
Induced Preferences	SI_1 Eff Equ SI_3 SI_2	SI_2 Equ Eff SI_1 SI_3	SI_3 Equ Eff SI_2 SI_1	↑
		PV		Votes
SI_1	13	0	0	13
SI_2	0	9	0	9
SI_3	0	0	8	8
Equ	0	0	0	0
Eff	0	0	0	0
		AV_2		
SI_1	13	0	0	13
SI_2	0	9	0	9
SI_3	0	0	8	8
Equ	0	9	8	17
Eff	13	0	0	13
		AV_3		
SI_1	13	0	0	13
SI_2	0	9	0	9
SI_3	0	0	8	8
Equ	13	9	8	30
Eff	13	9	8	30
		BC		
SI_1	42	9	0	51
SI_2	0	36	8	44
SI_3	13	0	32	45
Equ	26	27	24	77
Eff	39	18	16	73

Figure A.15: Predicted outcomes under sincere voting for Societies 3 and 4 in HET.

Appendix G Number of Approvals

For the case of AV, Table A.2 displays the average number of approvals in each society and experiment. Essentially, voters approved slightly less than two options on average for Societies 1–2 (where four options were available), and of between 2.2 and 2.5 for Societies 3–4 (where five options were available).

Society	SE	LE	ME
Society 1	1.84	–	–
Society 2	1.88	–	–
Society 3	2.23	2.47	2.44
Society 4	2.18	2.53	2.48

Table A.2: Average number of approvals under AV in the experiments.

Appendix H Experimental instructions

Appendix H.1 Small Electorates (laboratory)

Welcome to the experiment. The total duration of the experiment will be about 1 hour and 30 minutes.

In case there is something you do not understand now or during the course of the experiment, please raise your hand and remain seated. An experimenter will come to you and answer your questions.

It is important that you carefully read the following instructions as well as the additional information on screen, before making a decision.

During the experiment, you are not allowed to talk to or communicate in any other way with the other participants in the experiment. If you do not comply with this rule, you may be excluded from the experiment.

We now explain the course of the experiment. The experiment consists of four decision parts, and a questionnaire.

In the decision parts, you will be able to earn experimental currency units (ECU). The amount of ECU you will earn, depends on your decisions and the decisions of other participants in the experiment. At the end of the experiment, the total amount of ECU you have earned during the experiment is converted to EURO. The exchange rate for ECU to EURO is as follows.

1 ECU = 0.20 EUR, that is, 100 ECU = 20 EUR

Additionally, you will receive a show up fee of 4 EUR independently of your decisions during the experiment. The sum of your earnings will be paid to you in cash and privately at the end of the experiment.

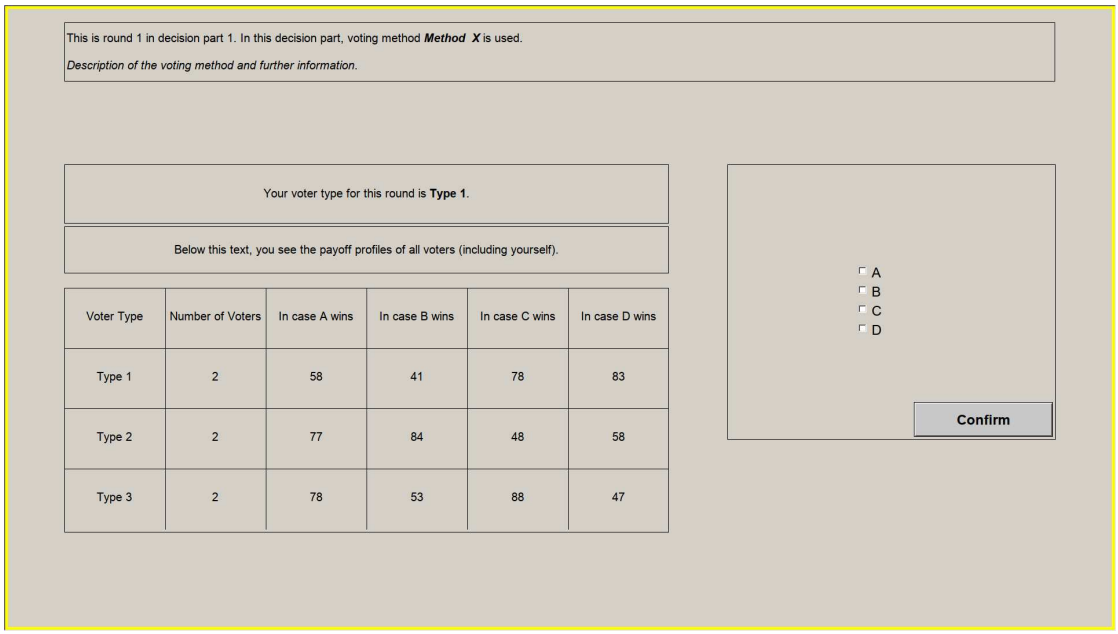
Voting decisions

In each of the four decision parts, you will participate in a series of elections. For this purpose, you are assigned to a group with 5 other, randomly chosen participants. Each decision part will use a different voting method, which will be explained to you in detail at the beginning of the respective decision part. There are up to five available alternatives, A, B, C, D, and E, which you can vote for. In each round, your task is to cast a valid ballot for the voting method used in that round. Please not that you are not allowed to abstain, that is, you have to submit a valid ballot for each of the elections.

Your payoff will be determined as follows. At the end of the experiment one election will be randomly selected and the result of that election determines your payoff in ECU. It does not matter whether you voted for the winner or not. Your payoff only depends on the outcome of the election, that is, which alternative is declared the winner of the election. Your payoff profile, that is, the amount of ECU you earn depending on which alternative is the winner, will be shown to you on screen in each round. Your payoff profile and the payoff profiles of the other participants may change from round to round.

The voting interface

The example below shows a typical decision screen. However, the screens will look slightly different depending on which voting method is used. The exact numbers used in this example are only meant as an illustration, the general layout of the screen, however, will be the same in the experiment.



- At the top of the screen, you see the current voting round. Further, you will find there a description of the voting method used in this round.
- Directly below on the left, you will see your type for this round. In this example, you are a voter of type 1.
- The box at bottom left of the screen shows the payoff profiles of all six voters in your group (yourself included) in the form of a table.
- On the right, you see the ballot with the available alternatives. Depending on the voting method, the exact form of the ballot may vary. Please fill in the ballot according to the description of the voting method used in that round. In this example, you can vote for an alternative by checking the corresponding box next to that alternative. You can submit your ballot by pressing the "Confirm" button.

How to read your payoff profile

In the example above, you would earn the following payoff in ECU depending on which alternative wins the election.

- If alternative A wins, then you receive 58 ECU.

- If alternative B wins, then you receive 41 ECU.
- If alternative C wins, then you receive 78 ECU.
- If alternative D wins, then you receive 83 ECU.

If in this example alternative B wins the election, then your payoff is 41 ECU. You will receive this amount independent of whether you have voted for alternative B or not. Only the winning alternative of the election determines your payoff. Please note that the payoff profiles in the experiment will differ from this example.

How to read the payoff profiles of the other voters

On the bottom left of the screen you see the payoff profiles of all voters in your group. This includes your payoff profile. The first column shows the the different types of voters. The second column shows the number of voters who have the payoff profile of the corresponding type. In this example, you are a voter of type 1, that is, your payoff profile is the one shown in the row labeled "Type 1." In this case you are one of two voters with this payoff profile, that is, there is one other voter with this profile, there are two other voters with the profile in the row labeled "Type 2," and two other voters with the payoff profile shown in the row labeled "Type 3."

In this example, the row labeled "Type 1" indicates that a voter of type 1 receives 58 ECU if alternative A wins the election, 41 ECU if alternative B wins the election, 78 ECU if alternative C wins the election, and 83 ECU if alternative D wins the election. The second row indicates that voters of type 2 receive 77 ECU if alternative A wins the election, 84 ECU if alternative B wins the election, 48 ECU if alternative C wins the election, and 58 ECU if alternative D wins the election. The last row indicates, that voters of type 3 receive 78 ECU if alternative A wins the election, 53 ECU if alternative B wins the election, 88 ECU if alternative C wins the election, and 47 ECU if alternative D wins the election.

Note that the total number of voters represented in the table adds up to 6. That is, the table contains the payoff profiles of all voters in your group: Your payoff profile and the payoff profiles of the 5 other voters. Please remember that the payoff profiles in the experiment will differ from this example. Further, the number of available alternatives may vary from round to round.

Comprehension questions.

Please answer the following comprehension questions by clearly marking the correct answer.

- Question 1: Your payoff in ECU that you can earn in a given voting round depends on

which alternative wins the election | which alternative I vote for

- Question 2: I receive a payoff for the election outcome of

  every election | one randomly selected election

- Question 3: In each round, I know the payoff profiles of the other five voters in my group, true or false?

  true | false

- Question 4: Consider the payoff profile from the example above. How many of the other voters in your group have the same payoff profile as you?

  2 other voters | 1 other voter

- Question 5: Consider the payoff profile from the example above. If you are a voter of type 1 in this example, what is your payoff if alternative C wins the election?

  78 ECU | 48 ECU | 88 ECU

On screen description of voting methods

Plurality Voting

For voting method 1, you can vote for exactly one alternative, and the alternative with the most votes is declared the winner of the election. In case of a tie between multiple alternatives, one of those alternatives is randomly selected as the winner with all tied alternatives having the same probability of being selected.

Approval Voting

For voting method 2, you can approve of as many alternatives as you wish. All alternatives you approve of will receive one vote, that is, all your approvals are weighted equally. The alternative with the most approvals is declared the winner of the election. In case of a tie between multiple alternatives, one of those alternatives is randomly selected as the winner with all tied alternatives having the same probability of being selected.

Borda Count

For voting method 3, you decide how to allocate points among the alternatives. Your task is to give 0 points to one of the alternatives, 1 point to one (other) alternative, 2 points to one (other) alternative, and so on. The maximal number of points that you can allocate to an alternative equals the number of alternatives minus 1, that is, when there are 4 alternatives then you can allocate a maximum of 3 points to one alternative. Please not that you have to allocate a different number of points to each alternative, so that a given number of points is only allocated to one alternative. The points each alternative receives are summed and the alternative with the most points is declared the winner of the election. In case of a tie between multiple alternatives, one of those alternatives is randomly selected as the winner with all tied alternatives having the same probability of being selected.

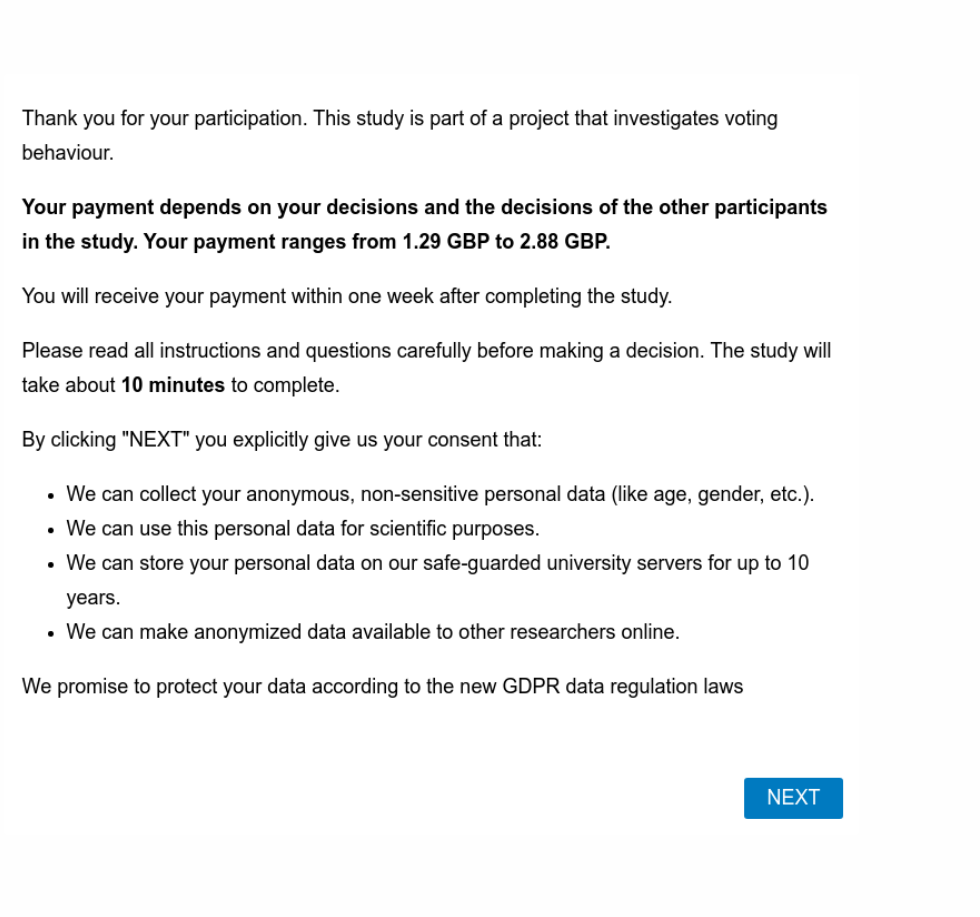
Random Dictator

For voting method 4, you and the other 5 voters make a decision, however, only the decision of a single voter will determine the outcome of the election. That is, one of the 6 voters (yourself included) is randomly selected and only this voter's decision determines the outcome independently of the decisions of the other voters.

For this voting method, you first select one alternative. However, there is a small probability of 5% that the alternative you have selected cannot be implemented. Therefore, in a second step you have to select a second alternative, in case your first selection cannot be implemented. Select as your second alternative, the alternative that you would select if the first one was not available. Also for this second alternative, there is a small probability of 5% that it cannot be implemented. Thus, in a third step you have to select a third alternative. Select as your third alternative, the alternative that you would select if the two alternatives you have selected so far were not available. If there are 5 available alternatives, then also for this third alternative there is a small probability of 5% that it cannot be implemented. In this case, you have to select a final alternative. Select as your final alternative, the alternative that you would select if the first three alternatives were not available.

Appendix H.2 Large/Medium Electorates (online)

The following screenshots show the instructions for the Large Electorates experiment. The instructions for the Medium Electorates used other payoff tables but were otherwise identical.



Thank you for your participation. This study is part of a project that investigates voting behaviour.

Your payment depends on your decisions and the decisions of the other participants in the study. Your payment ranges from 1.29 GBP to 2.88 GBP.

You will receive your payment within one week after completing the study.

Please read all instructions and questions carefully before making a decision. The study will take about **10 minutes** to complete.

By clicking "NEXT" you explicitly give us your consent that:

- We can collect your anonymous, non-sensitive personal data (like age, gender, etc.).
- We can use this personal data for scientific purposes.
- We can store your personal data on our safe-guarded university servers for up to 10 years.
- We can make anonymized data available to other researchers online.

We promise to protect your data according to the new GDPR data regulation laws

NEXT

Before you proceed, please answer the sports test. The test is simple, when asked for your favourite sport you must enter the word *clear* in the text box below.

Based on the text you read above, what favourite sport have you been asked to enter in the text box below?

clear

NEXT

The main part of the survey consists of three voting rounds.

In the voting rounds you can earn points that determine your payment. The amount of points you will earn depends on your decisions and the decisions of the other participants in the study.

At the end of the study, we will **randomly select one voting round for payment.** The outcome of this voting round determines your payment and the payment of all other participants.

Note that each voting round could be the one that counts for your payment. It is therefore in your best interest to consider your answer in each round carefully.

For payments points are converted to GBP using the following exchange rate:

1 Point = 0.03 GBP, that is, 100 Points = 3 GBP

NEXT

In each of the three voting rounds you participate in an **election involving a total of 1200 participants (voters) from Prolific, including yourself**. That is, each voter is another participant from Prolific.

Each voting round uses a **different voting method**, which will be explained to you in detail at the beginning of the round.

There are **five available alternatives** you can vote for: **A, B, C, D, and E.**

You can earn **different amounts of points** depending on which **alternative wins the election.**

In each round, your task is to cast a vote according to the rules of the voting method used in that round. Please note that you are not allowed to abstain, that is, you have to cast a vote for each of the elections.

Once all 1200 participants have completed the three voting rounds, one voting round will be randomly selected to determine your payment.

It does not matter whether you voted for the winner or not. Your payment and the payment of the other participants only depends on the election results, that is, which alternative is the winner of the election in the selected voting round.

NEXT

You and every other of the 1200 voters in the election is randomly assigned to one of **three voter types: Type 1, Type 2, or Type 3**.

The probability of being assigned each type is the same for all voters, that is, 400 participants will be assigned to each voter type.

Below you see an example of a payoff table, which shows the payoff profiles of all voters in the election. The first column shows the different voter types. The second column shows the number of voters with that type. **There are 400 voters of each type**, that is, there are 400 voters with the profile in the row labelled "Type 1," 400 voters with the profile in the row labelled "Type 2," and 400 other voters with the payoff profile shown in the row labelled "Type 3."

Voter Type	Number of Voters	If A wins	If B wins	If C wins	If D wins	If E wins
Type 1	400	58	41	75	83	62
Type 2	400	77	84	48	58	43
Type 3	400	78	53	88	47	64

Suppose you are a voter of Type 1. In that case your payoff profile would be the one shown in the row labelled "Type 1." For example, if alternative A wins, you and every other voter of Type 1 earn 58 points each, while voters of Type 2 earn 77 points each, and voters of Type 3 earn 78 points each. To give a second example, if alternative B wins, you and every other voter of Type 1 earn 41 points each, while voters of Type 2 earn 84 points each, and voters of Type 3 earn 53 points each.

NEXT

Based on the text you have read so far, please answer the following comprehension questions.

1) Your payment (in points) in a given voting round depends on ...

○ which alternative wins the election. ○ which alternative you vote for.

2) You receive a payment for ...

○ every voting round. ○ one randomly selected voting round.

3) In each voting round, you know the payoff profiles of all voters, true or false?

○ true. ○ false.

4) How many participants from Prolific take part in each voting round?

○ just myself. ○ 1200 participants from Prolific, including myself.

5) Consider the payoff profile below. If you are a voter of Type 2, what is your payment if alternative C wins the election?

Voter Type	Number of Voters	If A wins	If B wins	If C wins	If D wins	If E wins
Type 1	400	58	41	75	83	62
Type 2	400	77	84	48	58	43
Type 3	400	78	53	88	47	64

○ 58 points. ○ 88 points. ○ 48 points.

NEXT

Voting Round 1

In this round, you are asked to allocate points (from 1 to 5) among ALL alternatives. That is, you can give 1 point to one of the alternatives, 2 points to one (other) alternative, 3 points to one (other) alternative, and so on. The maximal number of points that you can allocate to one alternative is 5. Please note that you have to allocate a different number of points to each alternative (5, 4, 3, 2 or 1), so that any given number of points is only allocated to one alternative. **The points each alternative receives are added up and the alternative with the most points wins the election.** In case of a tie one of the winning alternatives will be randomly selected.

You are a voter of Type 1.

Below you see the payoff profiles of all voters, yourself included.

Voter Type	Number of Voters	If A wins	If B wins	If C wins	If D wins	If E wins
Type 1	400	91	44	56	65	61
Type 2	400	55	93	43	63	58
Type 3	400	49	58	96	67	91

Please allocate points (from 1 to 5) to the alternatives.

[ ] A [ ] B [ ] C [ ] D [ ] E

NEXT

Voting Round 2

In this round, you can vote for SEVERAL alternatives. That is, you can approve of as many alternatives as you wish. All alternatives you approve of will receive one vote, that is, all your approvals are weighted equally. **The alternative with the most approvals wins the election.** In case of a tie one of the winning alternatives will be randomly selected.

You are a voter of Type 1.

Below you see the payoff profiles of all voters, yourself included.

Voter Type	Number of Voters	If A wins	If B wins	If C wins	If D wins	If E wins
Type 1	400	91	44	56	65	61
Type 2	400	55	93	43	63	58
Type 3	400	49	58	96	67	91

Please select all alternatives you want to approve of.

A	B	C	D	E
☐	☐	☐	☐	☐

NEXT

Voting Round 3

In this round, you can vote for ONE alternative. That is, you can vote for exactly one alternative, and **the alternative with the most votes wins the election.** In case of a tie, one of the winning alternatives will be randomly selected.

You are a voter of Type 1.

Below you see the payoff profiles of all voters, yourself included.

Voter Type	Number of Voters	If A wins	If B wins	If C wins	If D wins	If E wins
Type 1	400	91	44	56	65	61
Type 2	400	55	93	43	63	58
Type 3	400	49	58	96	67	91

Please select the alternative you want to vote for.

A	B	C	D	E
○	○	○	○	○

NEXT

Please answer the following questions.

1) What was your voter type in the three voting rounds?

Type 1	Type 2	Type 3
○	○	○

2) Do you consider yourself a native English speaker?

Yes	No
○	○

3) How comprehensible were the instructions?

1 - not at all comprehensible	2	3	4	5 - very comprehensible
○	○	○	○	○

4) Please enter your ProlificID.

5) Do you have any further comments regarding the study?

NEXT