No. 70

UNIVERSITY OF COLOGNE

WORKING PAPER SERIES IN ECONOMICS

PORK BARREL POLITICS, VOTER TURNOUT, AND INEQUALITY: AN EXPERIMENTAL STUDY

JENS GROßER
THORSTEN GIERTZ

Department of Economics
University of Cologne
Albertus-Magnus-Platz
D-50923 Köln
Germany

http://www.wiso.uni-koeln.de

Pork barrel politics, voter turnout, and inequality: An experimental study*

Jens Großer (Florida State University)[i]

Thorsten Giertz (emeneo, Shanghai)[ii]

ABSTRACT

We experimentally study pork barrel politics in two-candidate majoritarian elections. Candidates form distinct supporter groups by favoring some voters in budget spending at the expense of others. We compare voluntary and compulsory costly voting and find that, on average, the former mode induces more narrowly targeted favors and therefore more inequality among otherwise identical voters. When the same candidates act over many elections, such as with parties, they tend to cultivate policy polarization by frequently favoring their exclusive supporters again and avoiding those of the opponent, and with compulsory voting we find additional frequent policy overlap for a separate subset of voters. Our findings are important for understanding how an inclination towards a sustained "divided society" can arise purely from the political process, absent of any coordination devices such as ideological preferences.

This version: January, 2014

Keywords: Pork barrel politics, voter turnout, inequality, Colonel Blotto games, laboratory experiments

[i] Florida State University, Departments of Political Science and Economics & Experimental Social Science at Florida State (xs/fs), 531 Bellamy Building, Tallahassee, FL 32306, U.S.A.
[ii] emeneo consulting, Shanghai, The People's Republic of China.

e-mail: jgrosser@fsu.edu; thorstengiertz@emeneo.com

* This is a much improved version of "Candidates, voters, and endogenous group formation: A Colonel Blotto experiment" (2009). We thank Walter Elberfeld, Tom Palfrey, and Arthur Schram for helpful comments. The paper has benefited greatly from comments of participants in seminars at the University of Amsterdam, University of Cologne, University of Hanover, Princeton University, and Florida State University, and at the 9th International Social Dilemma Conference in Chicago, the Public Choice Society and ESA meetings in San Antonio, the International ESA meetings at Harvard University, the 1st EPCR Meeting in Canterbury, the GEW Tagung in Cologne, and the Social Dilemmas Conference at Florida State University.

1 Introduction

Pork-barrel spending is a common practice in everyday policymaking.[1] In order to boost their chances in the election, candidates promise generous budget shares to subsets of the electorate, hoping to receive their votes and political contributions in return. For example, they promise subsidies to declining industries (e.g., the U.S. textile and coal industries; Dixit and Londregan 1995) and financial help for local infrastructure projects (e.g., building and improvements of roads and harbors). Such tactical redistribution has the potential to create inequalities between voters (Myerson 1993), and therefore to counteract the programmatic redistribution via taxes and the general welfare system that is rooted in the basic belief in equality (Dixit and Londregan 1996).[2] So far, political scientists and economists have studied tactical redistribution under the premise of compulsory voting, albeit voting is voluntary in most elections around the world.[3] So how then can the voting mode affect tactical redistribution? Through the costs of voting! If such costs are involved, then compulsory and voluntary voting can affect pork-barreling and thus inequality very differently. To wit, in order to lure voluntary votes, a candidate's promises to individual voters must not only exceed their promises received from the opponent, but also compensate for their voting costs. We therefore argue that under budgetary constraints, compared to the compulsory mode, voluntary voting forces candidates to target budget spending more narrowly (i.e., make more generous promises to fewer voters) and thus yields more inequality among otherwise homogenous voters. In the present paper, we utilize game theory and a laboratory experiment in order to study this relationship between the voting mode and inequality.

Consider our two-stage game of electoral competition, or *polity game*. In the first stage, two ex-ante identical candidates independently and simultaneously announce binding policy offers. That is, each targets individuals from a finite number of ex-ante identical voters (not including the candidates)

[1] For an annual overview of pork barrel projects in the United States, see for example Citizens Against Government Waste (http://cagw.org/reporting/pig-book).

[2] Here, we see tactical redistribution as allocation of *short-term* favors and programmatic redistribution as *long-term* policies that only change with major ideological shifts in the electorate (e.g., Dixit and Londregan 1996). According to Stokes (2009), a programmatic electoral strategy executes favors following a public debate, while this debate is absent in a non-programmatic strategy. In her taxonomy, our study is best categorized as "distributive politics" (i.e., favors are material, non-programmatic, biased, and not based on quid pro quo arrangements).

[3] The International Institute for Democracy and Electoral Assistance (IDEA) provides a list of countries with compulsory voting: http://www.idea.int/vt/compulsory_voting.cfm.

among whom, if she wins the upcoming election, a fixed budged is divided evenly. In the second stage, majoritarian voting takes place, with a tie-breaking coin flip, where the winning candidate gets a bonus ("spoils of office") and her policy offer is implemented, and the loser goes away empty-handed. Thus, candidates play a symmetric constant-sum game. We focus on *pure* tactical redistribution, to wit, candidates need only allocate a fixed budget among voters (as in Myerson 1993).[4] For example, they do not levy taxes or choose the budget level (Lizzeri 1999). And, we abstract away from exogenous ideological preferences (e.g., Cox and McCubbins 1986; Dixit and Londregan 1996, 1998) and economic inefficiencies that can accrue from pork-barreling (e.g., Baron 1991; Dixit and Londregan 1995), albeit efficiency and inequality are somewhat affected by the costs of voting.[5] As we are the first to compare pork-barreling with voluntary and compulsory voting, using pure redistribution seems appropriate.

For the polity game with compulsory voting and more than six voters, in any subgame perfect equilibrium in weakly undominated strategies, policy offers must be in mixed strategies and the two candidates have equal chances of winning. Also, voters cast a vote for the contender who promises them more money or, if they are indifferent, vote for either contender or blank (we focus on equilibria where each of these actions is chosen with probability one-third). If, to the contrary, a candidate uses a pure strategy that favors a minority of voters, then the opponent can win outright by targeting the remaining majority. And, if her pure strategy favors half of the electorate or more, then the opponent can win with more than fifty percent chance by targeting all except one of these voters, which is a best response. Thus, in any equilibrium the *egalitarian* offer can only appear in a strictly mixed strategy so, on average, tactical redistribution creates inequality among otherwise homogenous voters. While with compulsory voting any strictly positive *preference intensity* (or, difference in received promises) of a supporter is sufficient to garner her vote, in the voluntary mode the intensity must also compensate for the costs of

[4] In contrast to our study, in Myerson (1993) the number of voters is infinite and favors are iid draws from the candidates' offer distributions, so the budget constraint holds on average. Further, in equilibrium, ex post all voters have different offers and are never indifferent between the candidates, while in our model there are typically indifferent voters. For an overview of models of tactical redistribution, see for example Persson and Tabellini (2000).

[5] In the compulsory mode the costs of voting accrue to all voters alike, while in the voluntary mode only those who choose to turn out bear the costs. In this paper, a fixed budget means that voluntary voting is always the more efficient mode in the sense of cost-benefit analysis, unless everyone chooses to turn out in which case both modes are equally efficient. The greatest possible ex-post inequality is between victor's supporters who abstain and voters who receive no promise from the victor and turn out. Here, we concentrate on redistributive inequality solely created via budget spending.

voting. Therefore, we predict that pork-barrel spending is on average more narrowly targeted and hence creates more redistributive inequality with voluntary than compulsory voting.

In our study, different voter groups emerge from endogenous policymaking, and their sizes and compositions of preference intensities are publicly announced before voting. With voluntary voting, we then can analyze our elections as participation games with exogenous supporter groups and complete information about group sizes (Palfrey and Rosenthal 1983), which have also been studied in the laboratory (e.g., Großer and Schram 2010; Schram and Sonnemans 1996).[6] In any Nash equilibrium (henceforth NE) of these games, only voters with preference intensity equal to or larger than twice the voting costs have a positive turnout probability, and this probability also depends on all other voters' preference intensities, the electorate size, and supporter group sizes. In fact, a minority candidate can have higher chances in the election than her opponent due to smaller free-rider incentives in smaller groups, and this effect is strengthened if the minority also contains greater preference intensities than the majority, which regularly occurs in our game (cf. Campbell 1999). In contrast, with compulsory voting a majority candidate always has higher chances. However, NE fails to predict turnout levels and patterns in experimental participation games, which are much better explained by quantal response equilibrium (QRE; McKelvey and Palfrey 1995) that allows for noisy decision-making (e.g., Goeree and Holt 2005; Großer and Schram 2010). Our study provides first insights into how candidates and voters deal with the different complexities of the two voting modes.

Of central concern in pork barrel politics are the commitment problems involved. To wit, the candidates can never be sure that their supporters will vote for them, and voters in turn cannot take it for granted that policy promises will be fulfilled (e.g., Alesina 1988; Corazzini et al., forthcoming)—albeit promises are binding in our study so voters face no preference uncertainty. Also, political parties have long-term interests in keeping promises, and therefore are more trustworthy than legislators who are tempted to break party discipline in favor of their constituencies (Grossman and Helpman 2005). Here, we examine whether, and if so how, candidates and individual voters are willing and able to form

[6] In a basic participation game, two voter groups compete in a majoritarian election where each voter decides on whether or not to turn out to vote at a cost. Here, we define participation games more broadly, since in our study a relatively small number of elections can arise that are special cases of these games, such as the volunteer's dilemma game (Diekmann 1985).

long-standing tacit political alliances (i.e., via mutual promises and votes) and how such bonds impact pork-barreling and inequality. In our experiment, candidates are either *parties* who act in every election or *politicians* who change from election to election.[7] Importantly, politicians cannot respond to voter decisions in the current election,[8] while parties can reciprocate these decisions in their next policy offers—albeit with difficulties, as individual voter behavior could not be traced. Note that long-standing alliances are inconsistent with mixed strategy play and must rely on mutual reciprocity within the respective pair of a party and voter (e.g., Axelrod 1981; Kreps et al. 1982). But since individual voter behavior could not be traced, parties might reward and punish subsets of voters collectively via their budget promises. In practice, there are partisan voters and favors are often anchored in previous policies. Therefore, in spite of the possibility that rivals can challenge each other's alliances and the absence of coordination devices such as ideological preferences (e.g., Cox and McCubbins 1986; Dixit and Londregan 1996), we anticipate that some long-standing alliances also arise in the laboratory.

Our model belongs to the class of *Colonel Blotto games* (e.g., Borel 1921; Gross and Wagner 1950; Hart 2008; Owen 1968; Roberson 2006), where two antagonistic colonels independently and simultaneously allocate their forces across various battlefields, and the number of battles won determines the outcome of the war. These games find an immediate application in elections, where candidates battle for votes or voting blocs (e.g., Brams and Davis 1974; Laslier and Picard 2002; Myerson 1993; Sankoff and Mellos 1972; Snyder 1989; Young 1978). The extent of inequality caused by tactical redistribution depends on the specifics of the electoral competition. Myerson (1993) shows for different electoral rules (i.e., rank-scoring rules, approval voting, and single transferable votes) that increasing the number of candidates raises their incentives to target smaller subsets of voters, which yields more inequality. Dixit and Londregan (1996) find that candidates favor the more familiar allied voters if these can be targeted more effectively, but they favor swing voters if both types are equally receptive. In Lizzeri (1999), candidates accumulate national budget deficits since the additional money

[7] Note that some election campaigns emphasize parties (e.g., Dutch National Elections) and others center on politicians (e.g., U.S. Presidential Elections). Of course, outside of the laboratory politicians can to some extent coordinate policies across elections (e.g., using decisions of predecessors as clues) and parties sometimes disappear from the political arena. For illuminating the effects of the lifespan of candidates on policymaking, it is convenient to study our extreme cases.

[8] In our experiment, politicians randomly recurred now and then but seemed not to reciprocate their earlier election results.

can be used for more effective targeting. With regard to economic efficiency, Dixit and Londregan (1995) show that tactical redistribution can conserve declining industries (e.g., the U.S. textile and coal industries) and thus prevent resources from shifting to more efficient uses. The reason is that candidates cannot credibly promise future gains to those who need to shift. And, in Lizzeri and Persico (2001) candidates can engage in both tactical redistribution and efficiency enhancing public goods provision. They find that public goods are underprovided relative to the social optimum under various electoral rules (i.e., winner-take-all, proportional representation, and the Electoral College), and inequality is greater the more desirable public goods are. Finally, Lizzeri and Persico (2005) show that increasing the number of candidate leads to greater inefficiency. To our knowledge, we were the first to study the Colonel Blotto game experimentally[9] as well as examine pork-barreling with voluntary voting. In the conclusions, we elaborate on external validity by linking our findings to those of various related empirical studies that do, however, not utilize the framework of a Colonel Blotto game.

2 Polity game and predictions

In this section, we describe and analyze our game. Additional analysis is provided in our online supporting information.[10]

The polity game

Consider our two-stage electoral competition game, or polity game, with two ex-ante identical candidates, labeled $i = A, B$, and a finite number of ex-ante identical voters who are never candidates, labeled $j = 1, \dots, E$. In the first stage (*Policymaking*), the candidates independently and simultaneously announce binding policy offers. To wit, each of them targets individual voters to benefit from budget spending, with the only constraint that at least one voter is selected. Thus, there are $2^E - 1$ possible offers a candidate can choose from (4,095 in our experiment with twelve voters). If she prevails in the election, then a fixed budget $W_i = W > 0, i = A, B$ will be divided evenly between her n_i targeted voters, so each receives benefits of W/n_i (non-targeted voters receive zero benefits). And if she loses, then her

[9] The recent, independent experiments of Avrahami and Kareev (2009) and Chowdhury, Kovenock, and Sheremeta (2013) study asymmetric Colonel Blotto games, though not in the context of elections.
[10] The supporting information is available at https://sites.google.com/site/jwghome/research.

offer will be inconsequential. Note that targeting fewer voters increases each selected voter's benefits, which is a crucial relationship for our comparison of voting modes. In the second stage (*Election*), majoritarian voting takes place where a coin flip breaks a tie. The winning candidate gets a bonus, $\rho = 1$, ("spoils of office") and her offer is implemented, and the loser goes away empty-handed, $\rho = 0$. We assume that all players are risk neutral and maximize their expected own payoffs.

Each voter's *preference intensity* (PI), or difference in received promises, arises from endogenous policymaking. Namely, she may be targeted (i) by neither candidate so $PI = 0$ and she is indifferent between the two rivals; (ii) by one candidate so $PI > 0$ and she prefers this contender; or (iii) by both candidates, in which case she either prefers the contender who promises her more money ($PI > 0$) or is indifferent if both promise the same amount ($PI = 0$). Note that a variety of different compositions of preferences intensities can emerge that define a supporter group for each candidate and a group of indifferent voters with zero intensity. These groups vary in size, including nonexistence, and preference intensities, with a maximal in-group diversity of two different intensities in at most one supporter group. The following two examples illustrate the formation of preferences and voter groups. A full characterization of all possible elections is in the online supporting information.

Suppose that $E = 5$ and $W = 5$ in both examples.

Example 1:

$$\theta_A = (0\ 0\ 0\ 1\ 0) \qquad \omega_A = (0\ 0\ 0\ 5\ 0)$$
$$\theta_B = (0\ 1\ 1\ 0\ 1) \qquad \omega_B = (0\ \tfrac{5}{3}\ \tfrac{5}{3}\ 0\ \tfrac{5}{3})$$
$$\bar{\theta} = (0\ 1\ 1\ 1\ 1) \qquad \overline{PI} = \left(0\ \tfrac{5}{3}\ \tfrac{5}{3}\ 5\ \tfrac{5}{3}\right),$$

where on the left-hand side θ_i, $i = A, B$ denotes the vector of candidate i's selection of voters $j = 1, \ldots, 5$ (1 if targeted and 0 otherwise) and $\bar{\theta} = \theta_A + \theta_B$ gives the sum of the two rivals' vectors. And on the right-hand side, ω_i denotes the vector of candidate i's budget promises to each voter. In the example, A promises $W/n_A = 5$ to one voter ($n_A = 1$) and the remaining four voters are promised nothing, and B promises $W/n_B = 5/3$ to each of $n_B = 3$ voters and the other two voters are promised nothing. Also, vector $\overline{PI} = |\omega_A - \omega_B|$ denotes the vector subtraction where the resulting absolute elements give the preference intensity of each voter, respectively. There are two supporter groups G_A (consisting of voter

4) and G_B (voters 2,3, and 5), and G_0 consisting of indifferent voter 1. Note that the two offers do not overlap (i.e., $\theta_i < 2, i = A, B$) and each supporter group contains only one preference intensity.

Example 2:

$$\theta_A = (1\ 1\ 1\ 0\ 0) \qquad \omega_A = (\tfrac{5}{3}\ \tfrac{5}{3}\ \tfrac{5}{3}\ 0\ 0)$$
$$\theta_B = (0\ 0\ 1\ 0\ 1) \qquad \omega_B = (0\ 0\ \tfrac{5}{2}\ 0\ \tfrac{5}{2})$$
$$\bar{\theta} = (1\ 1\ 2\ 0\ 1) \qquad \overline{PI} = (\tfrac{5}{3}\ \tfrac{5}{3}\ \tfrac{5}{6}\ 0\ \tfrac{5}{2}),$$

where $n_A = 3$ and $n_B = 2$, and the two policy offers overlap for voter 3. Further, there are two supporter groups G_A (consisting of voters 1 and 2) and G_B (voters 3 and 5), and G_0 consisting of indifferent voter 4. This simple example already produces the maximum possible number of four distinct preference intensities, that is, 5/3 (5/6; 5/2; 0) for voters 1 and 2 (voter 3; voter 5; voter 4).

Finally, we distinguish between elections with voluntary and compulsory voting. In the voluntary mode, each voter decides on whether to pay a cost $c > 0$ and vote for candidate *A* or *B*, or to abstain at no cost. By contrast, in the compulsory mode each voter must pay c and vote for candidate *A* or *B*, or vote *blank* (i.e., vote for neither candidate).[11]

Equilibrium

We use backward induction in order to analyze in turn the polity game with compulsory and voluntary voting, focusing on subgame perfect equilibrium in weakly undominated strategies. In the *Policymaking* stage, candidates play a symmetric constant-sum normal form game where each cell represents one possible election (i.e., pair of offers) and its entries represent the rivals' probabilities of winning. Then, a *pure* strategy is a selection of specific voters (i.e., a policy offer) and a *mixed* strategy is a probability distribution over all pure strategies. It is helpful to sub-divide mixed strategies further. Specifically, a *pure* [*un*]*balanced number* strategy is a selection of one specific number of voters, where all pure strategies using this number are played with equal [at least two different] probabilities, and a *mixed* [*un*]*balanced number* strategy is a probability distribution over all pure balanced number strategies [all strategies with strictly positive probability for at least one pure unbalanced number strategy].

[11] We assume a penalty for abstaining that exceeds *c*, so this option is strictly dominated by voting sincerely and blank. For example, Australia uses the compulsory mode and voters have the option to cast a blank vote.

Proposition 1 (Polity game with compulsory voting and $E > 6$):[12] *In the Policymaking stage, in any NE in weakly undominated strategies each candidate has an equal chance of winning and always uses a strictly mixed balanced number strategy—thus, inequality is created on average—that cannot result in* $\lfloor E/4 \rfloor$ *targeted voters or less. In the Election stage, in a NE in weakly undominated strategies of every feasible pair of policy offers, each non-indifferent voter votes sincerely and each indifferent voter votes blank or for candidate A or B with probability one-third for each.*

Proof: See our online supporting information.

Thus, in equilibrium with compulsory voting, election results are entirely determined by the two supporter group sizes, and also chance if there are indifferent voters or ties. For indifferent voters, any voting strategy is optimal, which includes the random strategy used in Proposition 1 (various other strategies are analyzed in Großer and Giertz 2014). Further, candidates have equal chances as they can always imitate each other's strategy. Also, if some voters are more likely favored than others, then the opponent can achieve a greater than fifty percent chance of winning by targeting or avoiding these voters, so candidates do not use pure strategies or unbalanced number strategies in any NE. And, the opponent can exploit a pure balanced number strategy by a similar argument made earlier for the intuition of mixed strategy equilibrium in the *Policymaking* stage, so only a strictly mixed balanced number strategy is viable in NE.

Turning to voluntary voting, most of the emerging elections are *participation games* á la Palfrey and Rosenthal (1983), and all others are special cases thereof (such as the volunteer's dilemma game, Diekmann 1985; more details about the various games are provided below and in the online supporting information). For each possible election, the winning probabilities of the candidates (i.e., the respective cell's entries of the normal form game) are derived from the predicted turnout probabilities and votes, so NE can be solved.

[12] Focusing on electorates with more than six voters avoids special cases in both voting modes (see also Proposition 2). For example, if $E = 2$, then in both modes each possible offer pair is a NE. Or, if $E = 6$ and voting is compulsory, then the *Policymaking* stage also has pure strategy equilibria, which never occur for $E > 6$. Note that $E = 12$ in our experiment.

Proposition 2 (Polity game with voluntary voting and $E > 6$): *In the Policymaking stage, in any NE each candidate has an equal chance of winning and never uses any strategy that promises voters benefits of* $W/n < 2c$ *—thus, inequality is always created if* $E > W/2c$*. Also, at least one NE in pure or mixed balanced number strategies exists. And in the Election stage, in a NE in weakly undominated strategies of every feasible pair of policy offers, each voter with preference intensity* $PI < 2c$ *abstains and each voter with* $PI \geq 2c$ *turns out with positive probability and votes sincerely.*

Proof: See our online supporting information.

In the voluntary mode, in equilibrium election results depend on voters' turnout probabilities, which in turn depend on the voting costs, own and all other voters' preference intensities, and sizes of *relevant* supporter groups (i.e., that contain only voters with $PI \geq 2c$, compared to *original* groups in the compulsory mode where all voters count). A rational voter only turns out if her expected benefits from voting equals or exceeds the voting costs.[13] Then, anticipating NE decisions in the election, each candidate must promise her supporters $W/n \geq 2c$ in order to earn the chance of receiving their votes.

In addition, we make the following two conjectures:

Conjecture 1 (Effects of preference intensity and group sizes on turnout probabilities): *Ceteris paribus, a voter's turnout probability increases in her preference intensity and decreases in the absolute difference in supporter group sizes.*

Argument: Given the large variety of different elections, sufficiently general equilibrium properties of the effects of preference intensity and supporter group sizes on voter turnout are very difficult, if not impossible, to obtain. Thus, our conjecture is based on findings from related studies. First, in many experiments, higher incentives increase cooperation even if NE predicts no or opposite effects (e.g., Palfrey and Prisbrey 1997). For example, in a laboratory participation game on reforms with exogenous groups, Cason and Mui (2005) find that turnout rates decrease in the voting costs. Hence, we anticipate that turnout and preference intensity are positively associated in our experiment. Also, in Großer and

[13] A vote only raises the individual's benefits if it is pivotal (i.e., forces or breaks a tie, given others' votes). This increase equals $PI/2$ (i.e., the one-half stems from a tie-breaking coin flip) so she turns out with positive probablity if and only if $PI/2 \geq c$.

Schram (2010) turnout rates decrease in the absolute difference in exogenous supporter group sizes (as in Levine and Palfrey 2007 where voting costs are private information), which is against the NE predictions but in line with QRE (McKelvey and Palfrey 1995) and groupthink models (e.g., Feddersen and Sandroni 2006). QRE allows for decision-making errors that arise from bounded rationality (e.g., biased perceptions of costs and benefits) where a parameter μ controls the degree of noise.[14] For our data, we expect $\mu > 0$ of a magnitude similar to those in participation game experiments (e.g., Goeree and Holt 2005; Großer and Schram 2010) and hence strictly positive turnout rates even for voters with $PI < 2c$ who abstain in NE.

Finally, using backward induction, Propositions 1 and 2 and Conjecture 1 hold for each repetition of the finitely played polity game, independent of whether candidates are parties who act in every election or politicians who change from election to election.

Conjecture 2 (Inequality and the voting mode): *Voluntary voting creates more redistributive inequality among otherwise identical voters than compulsory voting, while inequality is the same with parties and politicians.*

Argument: In the voluntary mode, candidates' promises must sufficiently compensate for the supporters' voting costs in order to earn the chance of receiving their votes (e.g., in NE only voters with $PI \geq 2c$ turn out with positive probability). The compensation must be financed by favoring on average fewer voters than with compulsory voting, so voluntary voting tends to create more inequality. Further, in line with the conjecture, in NE candidates never target $n \leq \lfloor E/4 \rfloor$ and $n > W/2c$ voters with compulsory and voluntary voting, respectively (Propositions 1 and 2). Finally, offers of parties and politicians should not be different, as our predictions hold for each repetition of the finitely played polity game.

[14] In QRE players make stochastic best responses, that is, more lucrative decisions occur more often than less lucrative ones. In the logit specification of Goeree and Holt (2005), for example, $\mu = 0$ in the noise-free extreme (i.e., QRE turns into NE) and $\mu \to \infty$ in the other extreme with pure noise (i.e., everyone turns out with probability one-half). Besides turnout patterns, QRE can also explain other important empirical phenomena, such as that majorities win more often than minorities where NE predicts the opposite (Großer and Schram 2010). But note that observed candidate choices of voters are often closer to the NE than QRE predictions (e.g., McKelvey and Ordeshook 1990, albeit indifferent voters are usually not examined).

3 Procedures and experimental design

The computer experiment[15] was run at the CREED laboratory, University of Amsterdam. In total, 184 students attended twelve sessions of fourteen to eighteen participants that lasted about two hours (for the read-aloud instructions, see our online supporting information). Earnings were expressed in tokens and exchanged for cash for one f per four tokens at the end of the experiment. Participants earned an average of f38.31 (≈ € 17.38), including a f10 show-up fee.

In each session, a *polity* consisted of two candidates and twelve voters. Each participant was either a candidate or voter throughout the session, and was informed about her or his role at the start of the experiment. We study two treatment variables in a between-subjects design, varying the voting mode (*Compulsory* versus *Voluntary*) and lifespan of candidates (*Parties* versus *Politicians*). With compulsory voting, each voter automatically paid one token and had to vote *blank* or vote for candidate *A* or *B*. With voluntary voting, each voter decided on whether to spend one token in order to vote for either candidate, or to abstain at no cost. For the candidates' lifespan, in *Parties* two participants from a pool of fourteen were randomly appointed "Candidate *A*" and "Candidate *B,*" respectively, once and for all at the start of the session, and the remaining twelve participants were voters throughout. In *Politicians*, six participants from a pool of eighteen were randomly appointed *potential* candidates once and for all at the start of the session, and the remaining twelve participants were always voters. Before each election, all six potential candidates chose their offers, and thereafter two politicians were randomly appointed *actual* "Candidate *A*" and "Candidate *B*."[16] This procedure not only provides us with more offer observations, but also averts implicit coordination across elections via the *A*- and *B*-labels, so interactions of politicians are roughly one-shot encounters.

Each session consisted of 51 periods with two decision stages each. In the first stage, candidates independently and simultaneously made their policy offers by targeting individual voters (i.e., click on buttons that were arranged in a circle on the screen, where each button represented the same voter throughout the session). In the second stage, the two (actual) offers were announced and majoritarian

[15] We used RatImage (Abbink and Sadrieh 1995) to program the experiment.
[16] We used the same predetermined random sequence of actual candidates in all *Politicians* sessions, where each potential candidate was an actual candidate fifteen, seventeen, or nineteen times (see our online supporting information).

voting with random tie-breaking took place. Thereafter, a budget of eighteen tokens was divided evenly between the winner's targeted voters (non-targeted voters received zero tokens), while the loser's policy offer was inconsequential. In order to avoid negative earnings due to the costs of voting, each voter received one extra token independent of her or his decision. Also, the bonus for the winning (losing) candidate was twenty (zero) tokens. Further, voters were paid for each period, and candidates in *Parties* (*Politicians*) were paid for seventeen periods randomly selected at the end of the session (i.e., each period in which they were actual candidates; see footnote 16).

When making their decisions, candidates knew if in the previous period a specific voter was targeted by *A* or *B* or both candidates (i.e., this was visible on the voter buttons on the screen), but not her or his decision. And, when voters made their decisions they knew their own received promises and those made to all other voters, but could not trace others' promises from previous periods. Finally, all participants were informed about the procedures outlined here and in the instructions.[17] Table 1 summarizes our treatments and parameters:

Table 1: Summary of treatments and parameters

Treatment	Candidate payoffs for winning (losing)	Voter payoffs		Number of actual (potential) candidates
		Benefits if (not) targeted by winner	Costs of participation (abstention)	
Compulsory voting-Parties	20 (0)	$1 + 18/n_w$ (1)	1 (-)	2 (2)
Voluntary voting-Parties	20 (0)	$1 + 18/n_w$ (1)	1 (0)	2 (2)
Voluntary voting-Politicians	20 (0)	$1 + 18/n_w$ (1)	1 (0)	2 (6)

Note: n_w denotes the number of voters targeted by the winner. All treatments had 51 decision periods and twelve voters. We have four independent observations (i.e., polities or sessions) per treatment.

For our experimental parameters $E = 12$, $W = 18$, and $c = 1$ we employed GAMBIT (McKelvey et al. 2013) to compute symmetric NE in strictly mixed balanced number strategies of the *Policymaking* stage, which is shown in Table 2.

[17] The instructions used more neutral labels for roles and decisions than the paper (see our online supporting information).

Table 2: NE prediction of the number of targeted voters with compulsory voting

Number of voters targeted	1	2	3	4	5	6	7	8	9	10	11	12
Probability used in NE	0	0	0	0	.291	.344	0	.044	.079	.070	.098	.074

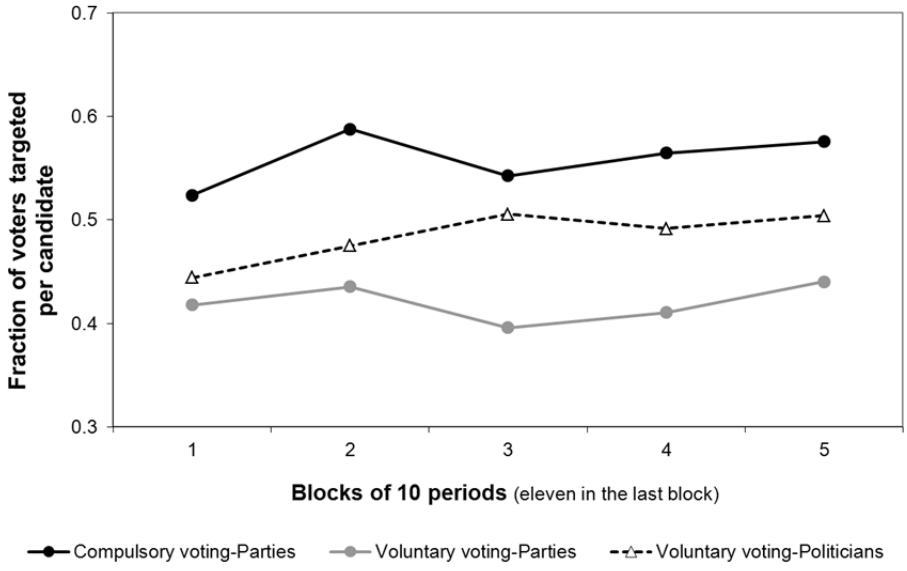
Note: Candidates target on average 7.24 out of twelve voters (60.4%).

Because of the complexity of the *Election* stage with voluntary voting, we cannot provide subgame perfect equilibrium predictions for this mode for our experimental parameters (albeit NE can be computed for each possible election, and the equilibrium conditions are in the supporting information).

4 Experimental results

In this section, we present and analyze our experimental results, starting with aggregate candidate and voter behavior. Thereafter, we study whether turnout and vote decisions are affected by the own preference intensity, absolute difference in supporter group sizes, and repeated favoritism by a candidate. Finally, we examine simple policy dynamics and long-standing alliances between candidates and voters. For our nonparametric statistical analysis we treat the polity, or session, as the unit of independent observation. Additional probit regressions of candidate and voter behavior are run with random effects at the individual level.

Figure 1: Average fraction of voters targeted per candidate



Aggregate behavior

We examine aggregate candidate and voter behavior, in turn. Figure 1 shows for each treatment observed fractions of voters targeted per candidate, averaged over blocks of ten periods (eleven in the last block). In *Politicians*, the policy offers of all potential candidates are included.[18]

As seen in the figure, there is considerable redistributive inequality in all treatments, that is, the average fractions of voters targeted per candidate are much smaller than one (i.e., the egalitarian offer). Further, the fraction is smaller in *Voluntary voting-Parties* than *Compulsory voting-Parties* in each block of periods (overall, 0.42 versus 0.56). In the first block the gap is about 0.10 points, and increases to about 0.15 points in the remaining blocks. Also, with voluntary voting the average fraction of voters targeted per candidate is smaller in *Parties* than *Politicians* in each block (overall, 0.42 versus 0.48, albeit this difference is not statistically significant). The fractions are similar in the first two blocks (0.42 versus 0.44 and 0.44 versus 0.48), but greater gaps of 0.06 to 0.11 points occur in the remaining blocks.

Experimental result 1: *There is substantial redistributive inequality in all treatments. On average, parties create greater inequality in the voluntary than compulsory mode, and inequality is the same for parties and politicians with voluntary voting.*

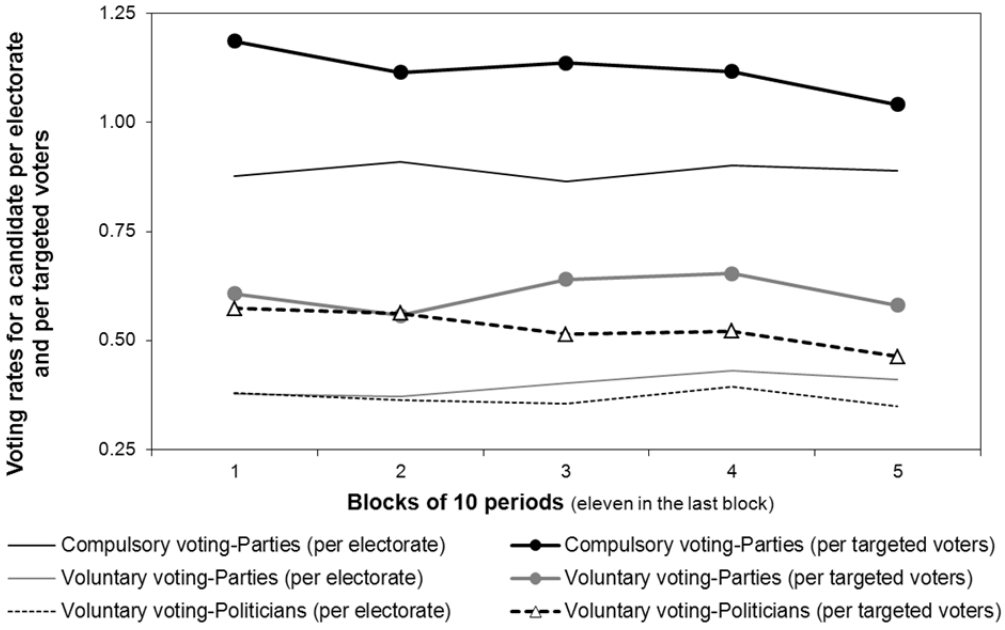
Support: One-tailed Wilcoxon-Mann-Whitney tests reject the null hypothesis of no difference in average fractions of voters targeted per candidate in favor of smaller fractions in *Voluntary voting-Parties* than *Compulsory voting-Parties* ($p = 0.029$), but not for *Voluntary voting-Parties* versus *Voluntary voting-Politicians* ($p = 0.171$). The exact same results also hold for the last three blocks of periods only. For comparison, average fractions are smaller in *Voluntary voting-Politicians* than *Compulsory voting-Parties* ($p = 0.100$), but no difference is found if only the last three blocks are considered ($p = 0.171$).

Confronting this result with our NE, in the compulsory mode (see Table 2 for predictions) the average fraction of voters targeted per candidate is with 0.56 close to the 0.60 in NE. Also, out of 408 policy offers, 3, 4, 5, 25, and 77 offers targeted one, two, three, four, and seven voters, respectively, compared to the zero predicted. In NE with voluntary voting, each candidate targets at most $W/2c = 9$ voters (Proposition 2). In *Voluntary voting-Parties*, 3, 1, and 13 out of 408 policy offers targeted ten, eleven, and twelve voters, and in *Voluntary voting-Politicians*, for the two actual (six potential)

[18] Average policy offers in *Politicians* are not different between the six potential and two actual candidates (two-tailed Wilcoxon signed ranks test, $p = 0.313$).

candidates these numbers are 3, 2, and 18 out of 408 (19, 5, and 49 out of 1224). Thus, in all treatments, offers that never occur in NE are indeed rarely observed (with the only exception of seven targeted voters in the compulsory mode). Finally, consistent with Conjecture 2, average inequality is greater with voluntary than compulsory voting and, in the voluntary mode, the same for parties and politicians.

Figure 2: Average voting rates



Next, we turn to aggregate voter behavior. Figure 2 shows for each treatment observed rates of voting for a candidate *per electorate* (lines without markers) and *per targeted voters* (lines with markers), averaged over blocks of ten periods (eleven in the last block). The rates are computed as the total number of votes for the two candidates, divided by the electorate size respectively the number of voters who receive at least one promise. In the compulsory (voluntary) mode, the voting rate decreases with each blank vote (abstention). Therefore, when voting is compulsory the rate per electorate is smaller than one if there is at least one blank vote, and the rate per targeted voters is larger than one if there are more *A*- and *B*-votes of non-targeted voters than blank votes of targeted voters. Note that outside of the laboratory only turnout rates per electorate and per registered voters are reported.

The observed voluntary voting (or, turnout) rates per electorate are about the same in *Parties* and *Politicians* in the first two blocks of periods (0.38 versus 0.38 and 0.37 versus 0.36, respectively) and 0.04 to 0.06 points higher in *Parties* in the remaining blocks. In comparison, the levels and differences are greater for rates per targeted voters (0.61 versus 0.57 and 0.56 versus 0.56 in the first two blocks, and gaps of 0.12 to 0.13 points in the remaining blocks), since indifferent voters with no promises who abstain are not considered.[19]

Experimental result 2: *Voter turnout rates are similar with parties and politicians.*

Support: One-tailed Wilcoxon-Mann-Whitney tests cannot reject the null hypothesis of no difference in turnout rates per electorate and per targeted voters between *Parties* and *Politicians* ($p = 0.557$ and $p = 0.343$), and this also holds for the last three blocks of periods only ($p = 0.243$ and $p = 0.171$).

In *Compulsory voting-Parties*, the average voting rate per electorate is smaller than one in all blocks of periods. Also, the average rate per targeted voters is greater than one in all blocks, indicating that some indifferent voters with no promises nevertheless voted for A or B, which is consistent with our prediction that these voters vote randomly (Proposition 2; more about this below). This rate is highest in the first block and lowest in the last block (1.19 and 1.04, respectively), and it is greater (smaller) than one in three (one) out of four polities.

Voter behavior

In the following, we study turnout and vote decisions by taking into account the specific electoral composition (i.e., group sizes and pattern of preference intensities). We first categorize and present observed fractions of the various elections, and thereafter investigate whether non-indifferent and indifferent voters vote sincerely and randomly, respectively (Propositions 1 and 2). Finally, we use probit regressions in order to examine whether voter's decisions are affected by their own preference intensity, the absolute difference in supporter group sizes, and repeated favoritism by a candidate.

Electoral compositions

For an overview of the various electoral compositions in our experiment, we categorize elections using *relevant* supporter groups that consist merely of voters with $PI \geq 2$ (note that our analysis below also

[19] Recall that the turnout rate per targeted voters includes individuals with $PI \in (0,2)$, who abstain in NE (Proposition 2).

uses original supporter groups). Moreover, a game is called *standard* if every supporter in a relevant group has the same preference intensity, albeit PI can differ across groups, and *modified* if one relevant group contains two different $PI \geq 2$ (which, in the voluntary voting, requires an additional equilibrium condition). In *Voluntary voting-Politicians* (-*Parties*) we find 75.5% (81.4%) standard participation games, 5.9% (3.9%) modified participation games, 11.3% (11.3%) standard volunteer's dilemma games, 0% (0%) modified volunteer's dilemma games, and 7.3% (3.4%) games with universal abstention. And, in *Compulsory voting-Parties* these numbers are 71.1%, 2.0%, 12.7%, 0%, and 14.2%. Thus, overall, most elections are categorized as standard "participation games."

Sincere voting

With compulsory voting, 77.7% of all observed voter decisions were made with $PI > 0$, of which 89.2% (7.0%; 3.8%) were sincere (insincere; blank) votes. And, 63.6% (36.4%) of the remaining 22.3% votes with $PI = 0$ were for a candidate (blank). Moreover, with voluntary voting 66.2% (69%) of all voter decisions in *Politicians* (*Parties*) were made with $PI > 0$, of which 49.9% (43.3%) were abstentions, 48.8% (54.8%) sincere votes, and 1.3% (1.9%) insincere votes. Of the remaining 33.8% (31.0%) decisions with $PI = 0$, 92.9% (92.8%) were abstentions and 7.1% (7.2%) were votes for a candidate.[20]

Experimental result 3: *In the compulsory mode, non-indifferent voters mostly vote sincerely and indifferent voters vote for a candidate about two-thirds of the time. In the voluntary mode, non-indifferent voters who choose to turn out vote sincerely, and indifferent voters sometimes turn out to vote for A or B.*

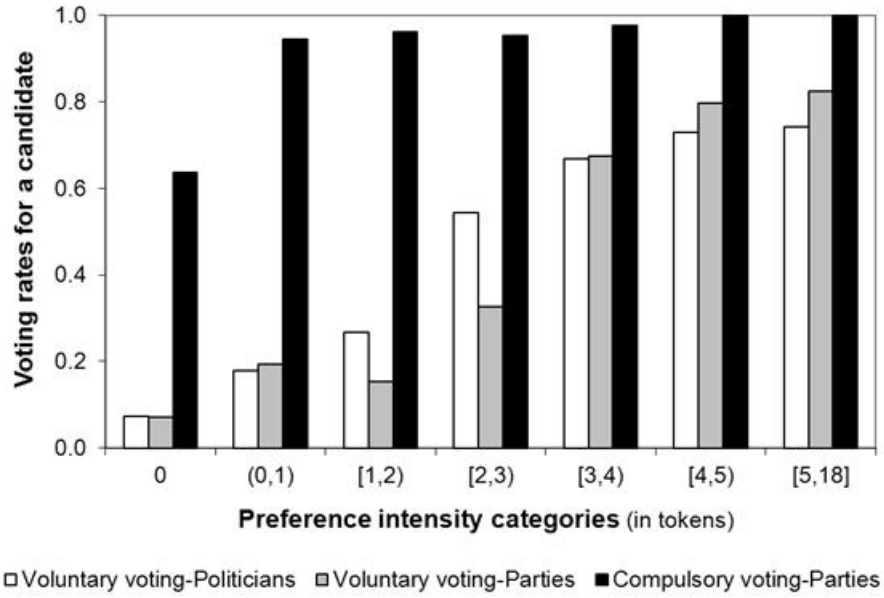
The result mainly supports Propositions 1 and 2 that non-indifferent voters vote sincerely in both voting modes, and that indifferent voters vote randomly in the compulsory mode (i.e., vote *blank* or for *A* or *B* with probability one-third for each). Although relatively small in numbers, the finding of non-indifferent insincere voting, especially in the compulsory mode, and indifferent voluntary voting is against NE but in line with QRE. Because insincere voting is quite rare and our focus is on voting for a candidate versus voting blank or abstaining, our following analysis simply assumes that non-indifferent voters who go to the polls vote sincerely.

[20] Note that 49 (25; 22) out of 204 election results in *Compulsory voting-Parties* (*Voluntary voting-Parties*; *Voluntary voting-Politicians*) change if decisions of indifferent voters are excluded.

Voting decisions

Figure 3 depicts observed average voting rates for a candidate per treatment per different categories of preference intensities. In all treatments, the intensity markedly affects the decision to (turn out to) vote for a candidate. As can be seen, very similar patterns of voluntary turnout rates are found in the two respective treatments, where the rates generally increase in the PI-category. A main difference between *Voluntary voting-Politicians* and *-Parties* is that the biggest jump in turnout rates occurs in different categories (0.35 in $PI \in [2,3)$ versus 0.28 in $PI \in [3,4)$, respectively). By contrast, in *Compulsory voting-Parties* the voting rate for a candidate is 0.64 for indifferent voters, $PI = 0$, and very close to one for all categories with $PI > 0$ (0.96 overall). At large, our findings are in line with Propositions 1 and 2.

Figure 3: Voting rates and preference intensities



Next, we further examine voter decisions by running, for each treatment separately, probit regressions with random effects at the individual level. Specifically, our panel models estimate the effects of the preference intensity, absolute difference in supporter group sizes, repeated favoritism by a candidate, and inequality concerns on the individual decision to (turn out to) vote for a candidate. Our dependent dummy variable, D_{jt}, equals one if voter j voted for A or B in period t, and zero otherwise. Further, we utilize the following independent variables. To begin, PI_{jt} measures j's preference intensity in tokens in period t. For the compulsory (voluntary) mode, the dummy variable $dPI_{jt}^{>0}$ ($dPI_{jt}^{\geq 2}$) equals

one if $PI_{jt} > 0$ ($PI_{jt} \geq 2$) tokens and zero otherwise, which allows us to examine a jump in voting rates for this intensity range versus $PI = 0$ ($PI < 2$) tokens, as predicted in Proposition 1 (2). Also, for the voluntary mode, the interaction variable $PI_{jt} \times dPI_{jt}^{\geq 2}$ measures the effect of preference intensities of at least two tokens on the turnout probability. Moreover, ΔGS_{jt}^{O-}, ΔGS_{jt}^{O+}, ΔGS_{jt}^{R-}, and ΔGS_{jt}^{R+} measure the absolute difference in supporter group sizes in period t, where superscript "–" ("+") indicates that j is in the minority (majority) group and superscript "*O*" ("*R*") refers to *original* (*relevant*) groups consisting of voters with $PI_{jt} > 0$ ($PI_{jt} \geq 2$). We interact the ΔGS-variables with the dummy variables $dPI_{jt}^{>0}$ in the compulsory mode, and $dPI_{jt}^{(0,2)}$ (equal to one if $PI_{jt} \in (0,2)$ and zero otherwise) and $dPI_{jt}^{\geq 2}$ in the voluntary mode, so we can test whether voters with intensities in these ranges respond differently to supporter group size differences. Further, $INEQ_{jt} = |n_{At} - n_{Bt}|$ measures the absolute difference in the candidates' numbers of targeted voters in period t, which is utilized to examine whether indifferent voters in the compulsory mode decide based on inequality concerns (recall that their earnings do not depend on the election result; see also Feddersen, Gailmard, and Sandroni 2009). And, FAV_{jt} is a dummy variable equal to one if j is a supporter of the same candidate in periods $t-1$ and t, and zero otherwise, so we can test whether j responds to repeated (stronger) favoritism by a candidate. Finally, the variable *Period* (t) measures a time trend and ε_{jt} and μ_j are error terms, where the latter term is a random effect used to correct for the panel structure in our data. Table 3 gives the results of our probit estimations.[21]

We first focus on voluntary voting, where our estimates are very similar across treatments. To wit, for statistically significant coefficients the signs and significance levels are, with one exception, identical in *Politicians* and *Parties*. Specifically, the coefficients of the dummy variable $dPI_{jt}^{\geq 2}$ are large and positive, supporting our NE prediction that preference intensities of at least two tokens are important for inducing turnout (see Proposition 2). Also, $PI \in [0,2)$ and much less so $PI \geq 2$ positively affect the turnout probability (i.e., the coefficients of PI_{jt} are 0.78 and 0.57, and are reduced by the coefficients -0.62 and -0.40 of $PI_{jt} \times dPI_{jt}^{\geq 2}$, respectively). Note that the effect of $PI \in [0,2)$ is not predicted by NE (see Proposition 2) but consistent with QRE. Further, the absolute difference in relevant supporter group sizes, ΔGS^R, negatively affects the turnout probability of voters with $PI_{jt} \geq 2$, and somewhat

[21] The results are similar if we only consider the vast majority of elections categorized as standard "participation games."

stronger so in minorities than majorities (-0.23 versus -0.12 in *Politicians* and -0.46 versus -0.34 in *Parties*, respectively). These relationships are also reported for exogenous supporter groups (Großer and Schram 2010). Finally, the probability of turnout is unaffected by ΔGS^O for voters with $PI_{jt} \in (0,2)$ who abstain in NE, the period, and repeated favoritism by a candidate (i.e., the coefficients of the respective variables are statistically insignificant).

Table 3: Random effects probit regressions of voting for a candidate

Constant and Independent variables	**Coefficients**		
	Voluntary voting-Politicians	*Voluntary voting-Parties*	*Compulsory voting-Parties*
Constant	-1.72 (10.73)***	-1.72 (13.04)***	0.15 (0.88)
$dPI_{jt}^{>0}$	—	—	1.69 (6.35)***
$dPI_{jt}^{\geq 2}$	1.97 (11.76)***	2.18 (10.06)***	—
PI_{jt}	0.78 (8.70)***	0.57 (4.86)***	0.16 (1.93)*
$PI_{jt} \times dPI_{jt}^{\geq 2}$	-0.62 (6.36)***	-0.40 (3.07)**	—
$\Delta GS_{it}^{O-} \times dPI_{jt}^{>0}$	—	—	-0.07 (1.19)
$\Delta GS_{it}^{O+} \times dPI_{jt}^{>0}$	—	—	-0.05 (1.03)
$\Delta GS_{it}^{O-} \times dPI_{it}^{(0,2)}$	-0.05 (0.50)	0.28 (1.29)	—
$\Delta GS_{it}^{O+} \times dPI_{it}^{(0,2)}$	-0.06 (1.52)	0.02 (0.31)	—
$\Delta GS_{it}^{R-} \times dPI_{jt}^{\geq 2}$	-0.23 (3.91)***	-0.46 (7.43)***	—
$\Delta GS_{it}^{R+} \times dPI_{jt}^{\geq 2}$	-0.12 (3.75)***	-0.34 (8.39)***	—
$INEQ_{jt}$	—	—	0.13 (2.76)**
$INEQ_{jt} \times dPI_{jt}^{>0}$	—	—	-0.06 (1.09)
Period (t)	-0.00 (0.76)	-0.00 (0.67)	0.00 (1.13)
FAV_{jt}	-0.12 (1.57)	-0.06 (0.73)	-0.02 (0.12)

Note: The independent dummy variable is a voter's decision on voting for a candidate (= 1) or abstaining respectively voting blank (= 0). Absolute *z*-values are in parentheses, and * (**; ***) indicates significance at the 5% (1%; 0.1%)-level.

With compulsory voting, the estimates mostly support our NE predictions (see Proposition 1). Compared to indifferent voters, there is a statistically significant, large positive effect on voting for a candidate for non-indifferent voters, but also an unpredicted significant, small positive effect of the preference intensity (captured by the coefficients 1.69 of $dPI_{jt}^{>0}$ and 0.16 of PI_{jt}, respectively). And, in line with NE, neither minority nor majority voters respond to ΔGS^O. Finally, indifferent but not non-

indifferent voters do indeed somewhat resort to inequality concerns (i.e., the coefficient of $INEQ_{jt}$ is statistically significant and positive, and that of $INEQ_{jt} \times dPI_{jt}^{>0}$ is insignificant).

Experimental result 4: *With voluntary voting, turnout levels jump up drastically for preference intensities of at least two tokens. Further, the turnout rate increases in the preference intensity and, for voters with* $PI \geq 2$ *tokens in both the minority and majority, in the absolute difference in relevant supporter group sizes. With compulsory voting, non-indifferent voters almost always vote for a candidate, while indifferent voters do so two-thirds of the time and somewhat more likely for the candidate who allocates the budget more equally.*

Candidate behavior

In the following, we analyze candidate behavior in more detail. We first look at their winning rates, and thereafter examine simple policy dynamics (i.e., changes in offers from one election to the next), also using probit estimations with random effects at the candidate level.

Winning rates

For the more successful candidates per polity, the winning rates are 0.53, 0.55, 0.61, and 0.65 in *Compulsory voting-Parties*, 0.53, 0.55, 0.55, and 0.63 in *Voluntary voting-Parties*, and 0.51, 0.55, 0.57, and 0.63 in *Voluntary voting-Politicians*. Note that the lowest possible rate is $0.51 = 26/51$ periods.

Experimental result 5: *In one-third of the polities the candidates' winning rates are unequal*.

Support: In four out of twelve (3×4) polities one candidate wins statistically significantly more often than the rival(s). Binomial tests reject the null hypothesis of equal winning rates for these polities (one per treatment $p \leq 0.05$ plus one in *Compulsory voting-Parties*, $p \leq 0.10$) but not for all other polities ($p > 0.10$). Of the twenty four (4×6) potential candidates in *Politicians*, thirteen win more and eleven win fewer than half of their actual candidacies, which is significant for four respectively three of them ($p \leq 0.10$).

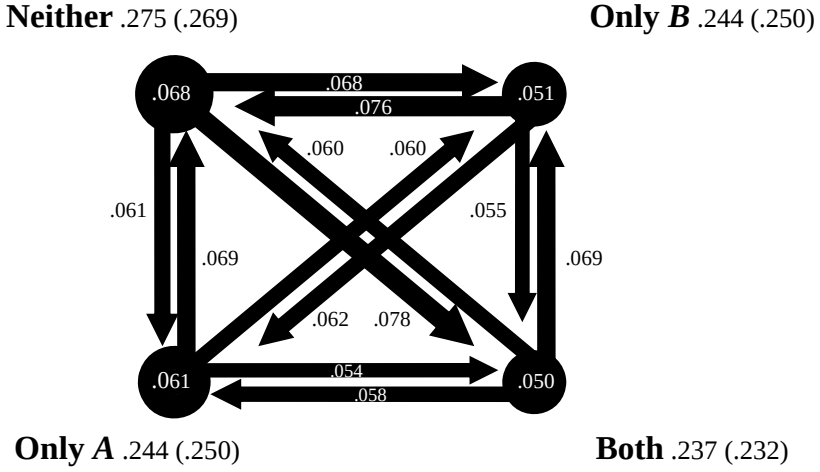
We conjecture that deviations from the predicted equal chances of candidates (see Propositions 1 and 2) are due to the complexity of policymaking.

Voter states and transitions

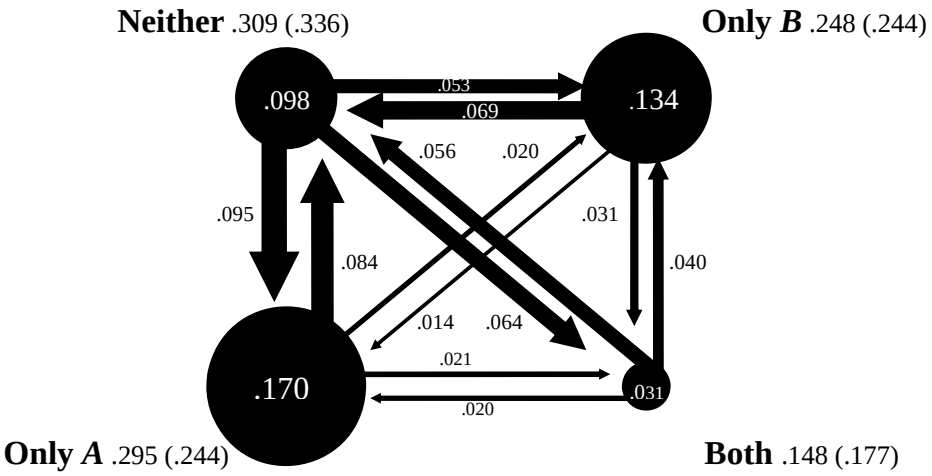
Next, we study whether candidates choose their policy offers depending on offers in the previous period. There are four possible "voter states," as defined by the promises a voter receives. Namely, she is targeted by (i) *Neither* candidate or (ii) *Only A* or (iii) *Only B* or (iv) *Both* candidates. Figure 4 depicts these voter states per treatment as "circles." Further, each voter either remains in the same state from one period to the next, or enters another state as represented by "arrows" directed to the new state. Therefore, each circle has three outgoing and three incoming arrows. For periods 1 to 50, observed average fractions of voters in each state are given in the figure next to the respective state's label (predictions are in brackets), and observed average fractions of remaining in and transiting to another state are given at—and visualized by the size of—the respective circles and arrows (predictions are explained in the text, and a full overview is available on request from the authors). Note that a state fraction is equal to the sum of its three fractions of outgoing transitions plus the fraction of remaining in that state. For example, in *Voluntary voting-Politicians* (top panel of Figure 4) the observed average state fraction of *Only A* is $0.244 = 0.069 + 0.060 + 0.054 + 0.061$.

Figure 4: Voter states and transitions between elections

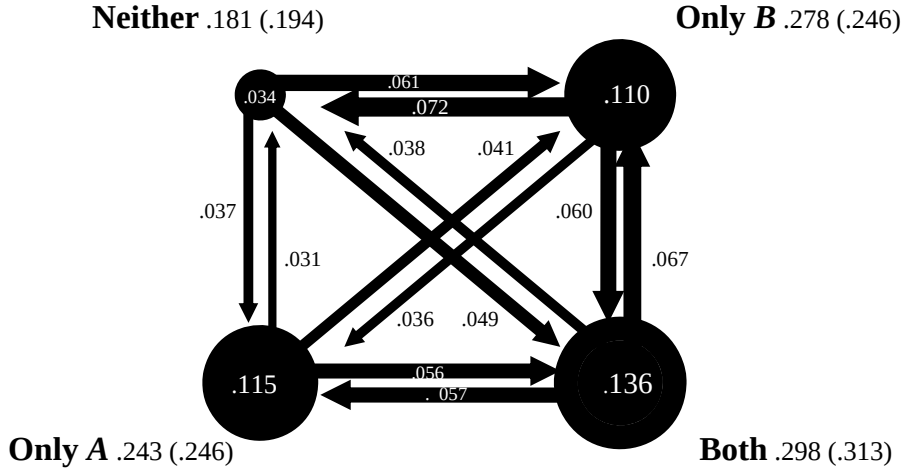
Voluntary voting-Politicians



Voluntary voting-Parties



Compulsory voting-Parties



We now examine whether candidates target individual voters randomly (see Propositions 1 and 2), using Binomial tests and probit regressions in turn. For the Binomial tests, we simply use per each treatment as our predicted target probability, labeled γ, the observed average number of voters targeted in an offer (i.e., in the given treatment, n_i is averaged over all candidates and 51 periods).[22] So, we have $\gamma = 0.48$ (0.42; 0.56) in *Voluntary voting-Politicians* (*Voluntary voting-Parties*; *Compulsory voting-Parties*). Assuming that each candidate's decisions on whether or not to target individual voters are independent from each other and her opponent's decisions, we then predict that each voter enters

[22] Note that γ does not capture any variation in target probabilities across candidates and periods. To some extent, such differences are accounted for in our probit regressions, below (see Table 4). Also, with probability $(1-\gamma)^{12}$ a candidate does not target any voter, but in our game at last one must be targeted. However, this probability is very small ($\leq (1-0.42)^{12} = 0.0014$) so our analysis is virtually not affected. Finally, the results are similar for various alternatives to γ.

state *Neither*, *Only A*, *Only B*, and *Both* with probability $(1-\gamma)^2$, $\gamma(1-\gamma)$, $\gamma(1-\gamma)$, and γ^2, respectively. And, the predicted probability of each outgoing transition is computed as the product of the respective probabilities of the departure and destination states. There are sixteen such probabilities per treatment, four for each voter state. For example, in *Voluntary voting-Parties* (middle panel of Figure 4) we predict that each voter enters *Neither* with probability 0.336 and her respective transition probabilities are $0.113 = 0.336 \times 0.336$ for *Neither*→*Neither*, $0.082 = 0.336 \times 0.244$ for *Neither*→*Only A,* $0.082 = 0.336 \times 0.244$ for *Neither*→*Only B*, and $0.059 = 0.336 \times 0.177$ for *Neither*→*Both*, with $0.113 + 0.082 + 0.082 + 0.059 = 0.336$.

Confronting our predictions with the data using Binomial tests,[23] in *Voluntary voting-Politicians* (top panel of Figure 4) none of the observed state fractions is statistically significantly different from our random benchmark, and only four out of sixteen fractions of outgoing transitions and remaining in a state are significantly different ($3 \times p \leq 0.1$ and $p \leq 0.01$). Further, in *Voluntary voting-Parties* (middle panel) these numbers are three ($p \leq 0.01$, $p \leq 0.001$, and $p \leq 0.0001$) and thirteen ($p \leq 0.1$, $2 \times p \leq 0.01$, and $8 \times p \leq 0.0001$), and in *Compulsory voting-Parties* (bottom panel) they are one ($p \leq 0.001$) and fourteen ($2 \times p \leq 0.1$, $p \leq 0.001$, and $11 \times p \leq 0.0001$). Therefore, and also visible in Figure 4, politicians target voters mostly randomly while parties deviate markedly from our random benchmark, and we examine next whether they do so systematically.

Focusing first on *Parties*, with voluntary voting the fractions of voters remaining in *Only A* and *Only B* are far greater than predicted, while the transition fractions of *Only A*→*Only B* and *Only B*→*Only A* are much smaller (all $p \leq 0.0001$). Thus, in the voluntary mode parties tend to cultivate polarized groups by repeatedly favoring their exclusive supporters and avoiding those of the rival. And, as seen in the middle panel of Figure 4, policy polarization is assisted in that voters who are newly included in (excluded from) offers are usually drawn from (released to) *Neither*, and those who happened to be in *Both* are usually released by both parties so they enter *Neither*. Moreover, in the compulsory mode the fractions of voters remaining in *Only A* and *Only B* are also far greater than in the random benchmark,

[23] In running our Binomial tests, for voter states we use $n = 2{,}400$ observations (4 sessions × 12 voters × 50 periods) and for transitions we use n_{actual} observations (i.e., the actual number of observations per state from where the respective transition departs), where n_{actual} ranges from 354 to 741.

however, the same holds for remaining in *Both* (all $p \leq 0.0001$) so in addition to policy polarization parties bump into each other's offers for some voters. And, as with voluntary voting, the transition fractions of *Only A*→*Only B* and *Only B*→*Only A* are much smaller than predicted ($p \leq 0.001$ and $p \leq 0.0001$). All in all, policy offers in the two *Parties* treatments are considerably predictable, which is inconsistent with mixed strategy play of candidates (see Propositions 1 and 2) and hints to some tacit agreements between parties towards focusing their battle for votes on a subset of voters.

Table 4: Random effects probit regressions of candidate behavior

	Coefficients		
Constant and Independent variables	*Voluntary voting-Politicians*	*Voluntary voting-Parties*	*Compulsory voting-Parties*
Constant	-0.20 (3.13)**	0.28 (4.44)***	0.39 (6.22)***
Period (t)	0.01 (4.36)***	0.00 (0.52)	0.00 (1.41)
Win_{t-1}	-0.12 (1.56)	0.20 (2.78)**	-0.09 (1.23)
$Neither_{j,t-1}$	0.15 (2.01)*	-0.38 (5.59)***	-0.34 (4.27)***
$Only\ Other_{j,t-1}$	-0.02 (0.32)	-1.13 (15.16)***	-0.67 (9.24)***
$Both_{j,t-1}$	-0.01 (0.16)	-0.54 (6.39)***	-0.01 (0.20)
$Neither_{j,t-1} \times Win_{t-1}$	0.05 (0.46)	-0.30 (3.08)**	0.11 (0.95)
$Only\ Other_{j,t-1} \times Win_{t-1}$	0.13 (1.29)	-0.58 (5.15)***	-0.12 (1.14)
$Both_{j,t-1} \times Win_{t-1}$	0.13 (1.23)	-0.13 (1.13)	-0.09 (0.90)

Note: The independent dummy variable is a candidate's choice whether to target a specific voter (= 1), or not (= 0). Absolute *z*-values are in parentheses. * (**; ***) indicates significance at the 5% (1%; 0.1%)-level.

Next, we analyze candidate behavior in more detail by running probit regressions with random effects at the candidate level. Specifically, we study whether the probabilities with which voters are targeted depend on previous voter states and are different after winning and losing. Our dependent dummy variable indicates whether or not (one or zero) candidate i targets voter j in period t. Our independent variables are the *Period* (t), measuring a time trend, and the following seven dummy variables (equal to one if true, and zero otherwise): Win_{t-1} indicates whether i won in the previous period; $Neither_{j,t-1}$, $Only\ Other_{j,t-1}$ (i.e., *Other* refers to candidate $-i \neq i$), and $Both_{j,t-1}$ indicate j's voter state in the previous period, respectively, so the constant represents the state where she or he was

targeted only by candidate i; and, finally, three variables that interact Win_{t-1} with each voter state variable, respectively. Our estimations are shown in Table 4.

In *Voluntary voting-Politicians*, our estimates are mostly consistent with mixed strategy NE play (see Table 2) in that policy offers are made independent of previous voter states and election results (i.e., six of the seven dummy variables are small and insignificant). Albeit relatively small, the two statistically significant exceptions are the negative constant and positive coefficient of $Neither_{j,t-1}$.[24] By contrast, in *Voluntary voting-Parties* candidates strongly respond to previous voter states and election results (i.e., the coefficients of the seven dummy variables are usually greater than for politicians, and six are significant). Specifically, exclusive supporters in $t-1$ are more likely favored again, and even more so after winning (i.e., the constant and coefficient of Win_{t-1} are positive and significant, and the coefficients of all other dummy variables are negative). Note that these estimates back up our earlier finding that parties tend to cultivate policy polarization—in particular, the negative coefficients of $Only\ Other_{j,t-1}$, $Only\ Other_{j,t-1} \times Win_{t-1}$, and $Both_{j,t-1}$ stand out the most, which accentuates the parties' active avoidance of the rival's targeted voters. Moreover, in *Compulsory voting-Parties* the constant is statistically significant and positive and the coefficients of $Neither_{j,t-1}$ and $Only\ Other_{j,t-1}$ are significant and negative, whereas all other coefficients are insignificant. Also these estimates are consistent with our earlier policy polarization finding, and comparing the coefficients of $Both_{j,t-1}$ in the two *Parties* treatments emphasizes the important difference caused by the voting mode: in the compulsory mode the estimate is miniscule while in the voluntary mode it is large and negative (i.e., -0.014 n.s. versus -0.540***)—hence, parties seek (avoid) policy overlap with compulsory (voluntary) voting. Also, interestingly, parties do not respond to election results when voting is compulsory (i.e., all coefficients of variables involving Win_{t-1} are insignificant). Thus, in contrast to voluntary voting, parties do not hold their targeted voters responsible for winning or losing, which is intuitive because the supporters' compulsory votes are almost always sincere, so there is virtually no room for

[24] One possible reason why politicians target voters in $Neither_{j,t-1}$ somewhat more often than other voters are fairness concerns (i.e., so that this time these voters have a chance to earn money). Recall that in this treatment some indifferent voters had fairness concerns too, as indicated by the $INEQ$-coefficient in Table 3.

reciprocating their decisions. In other words, parties know that they bear most of the responsibility for elections results under compulsory voting.

Finally, we find no period effects on the probabilities with which candidates target individual voters in *Parties* (i.e., both coefficients are statistically insignificant) and a significant, tiny positive effect in *Politicians*. We conjecture that these findings are due to the different feedback parties and politicians receive about their own policy offers. To wit, politicians are actual candidates only one-third of the time, while parties experience the consequences of their decisions in every period.

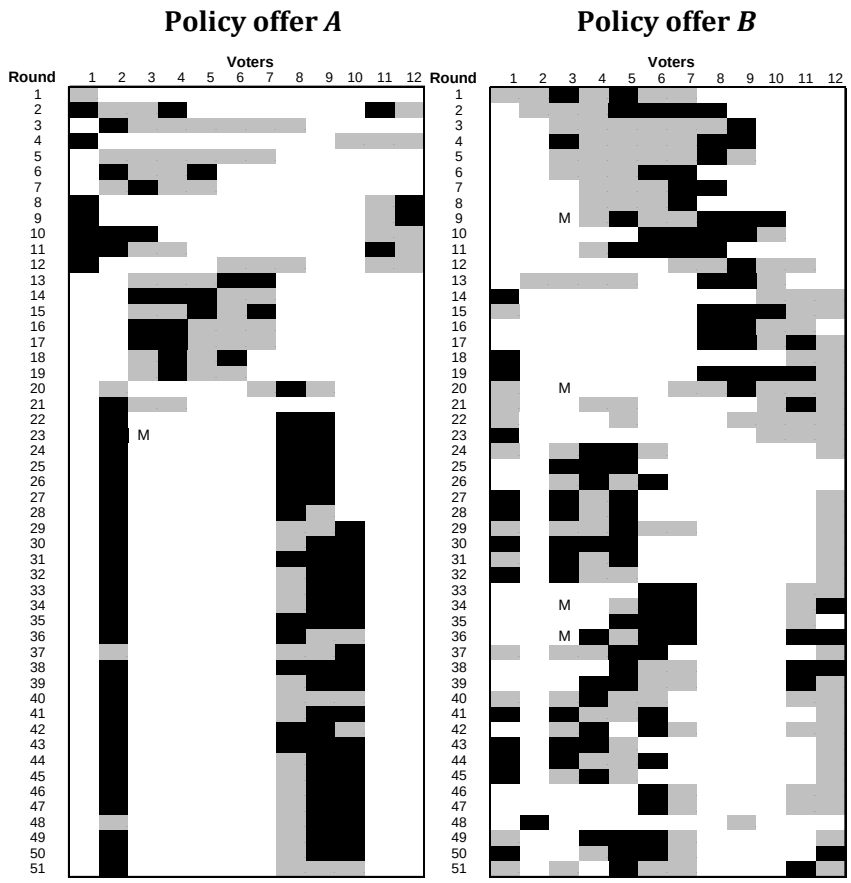
Experimental result 6: *Parties choose their policy offers based on voters' previous states. In both voting modes, they tend to cultivate policy polarization by repeatedly targeting their exclusive supporters again and avoiding those of the opponent, and in the voluntary mode this behavior is boosted after a victory. With compulsory voting, they also seek policy overlap for a separate subset of voters.*

Political alliances

We conclude our experimental results section by presenting a particularly illustrating example of the formation of long-standing tacit alliances between parties and individual voters (i.e., continuous mutual promises and votes). Recall that such alliances are inconsistent with mixed strategy play of candidates since the anticipation of bonds can usually be exploited by the rival. Also recall that in our experiment individual voter decisions were not revealed, so in order to sustain alliances parties had to reciprocate based on their subjective beliefs about these decisions. In short, it seems that lasting alliances between parties and voters are difficult to achieve.

Figure 5 depicts for one polity (Session 6, *Voluntary voting-Parties*) the decisions of each party and voter in every period. Policy offers of party A (B) are shown on the left-hand (right-hand) side, and on both sides each voter is represented by a column and each period by a row. A black (gray) cell indicates that in this period voter j was targeted by party $i = A, B$ and did (not) vote for this party. And, an "M" (white) cell indicates that in this period j was not targeted by i and did (not) vote for i. The example is self-explanatory, so we refrain from defining alliances by an exact duration of mutual favors.

Figure 5: Tacit political alliances in Session 6, *Voluntary voting-Parties*



Note: Party A's (B's) offers are shown on the left-hand (right-hand) side. On each side, each voter j is represented by a column and each period by a row. A black (gray) cell indicates that j was targeted by $i = A, B$ and did (not) vote for this party and an "M" (white) cell indicates that j was not targeted by i and did (not) vote for i.

As can be seen, party A persistently targets voters 2, 8, and 9 from period 22 onwards and voter 10 is added starting in period 29, and these favors are returned by a vote in 74.3% of the cases. Voter 8 often abstains, so alliances only form between A and voters 2, 9, and 10. By contrast, for period 21 onwards, party B targets voters less persistently and on average more of them than A (5.11 vs. 3.77 voters per period), yielding 45.2% of returned favors. Repeated mutual favors are short for B (at most five periods) so no alliances are found for this party. Note that both policies are clearly polarized from period 22 onwards (with only two overlaps in period 48). Surprisingly, although B wins only nine of these thirty elections, she or he does not attempt to increase the own chances via bumping into A's

alliances or making offers to fewer voters.[25] Generally, voters stop voting for a candidate as soon as an offer gets too small, which is in line with our finding that voters respond mainly to monetary incentives but not to favoritism per se, and that they have a stronger "bargaining" position than candidate as they decide after observing their policy offers. This example, and others that are available from the authors on request, yield:

Experimental result 7: *Some long-standing political alliances arise between parties and individual voters. These bonds are rational in the sense that voters only cast a vote for the party as long as their preference intensities do not get too small.*

5 Conclusions

Although pork-barrel spending is ubiquitous in everyday policymaking, many of its consequences are still not understood. Here, we provide novel insights on how voluntary versus compulsory costly voting can affect tactical redistribution and thus inequality. Our experimental results show that, for a fixed budget, candidates make on average greater promises to fewer voters with voluntary than compulsory voting, because in the former mode supporters must be compensated for the voting costs in order to earn the chance of receiving their votes. Thus, among otherwise homogenous voters, redistributive inequality is on average greater with voluntary voting. Further, the voters' decisions are generally similar to those reported in experiments using exogenous groups with both compulsory (e.g., McKelvey and Ordeshook 1990) and voluntary voting (e.g., Großer and Schram 2010; Levine and Palfrey 2007). That is, they vote sincerely most of the time and voluntary turnout rates are positively related to preference intensity and, for sufficiently high intensities, negatively related to the absolute difference in relevant supporter group sizes.

Our paper also adds to studies of electoral competition by comparing elections that center on politicians and parties, respectively. Specifically, parties can coordinate their policies across several legislative periods while politicians cannot, which we implement in the experiment as finitely repeated

[25] For an example of how B could defeat A, suppose that B targets five voters and bumps into all four supporters of A. This yields four A-supporters with $PI = 0.9$ tokens and one B-supporter with $PI = 3.6$ tokens. Theoretically, in NE all A-supporters abstain since $PI < 2$ tokens, and B wins outright as her or his only supporter surely turns out to vote sincerely.

versus nearly one-shot candidate encounters. We find that this distinction matters a lot. To wit, while politicians' promises to voters are virtually unpredictable across elections, parties tend to cultivate policy polarization by repeatedly favoring again their exclusive supporters and avoiding those of the opponent, so that some long-standing tacit alliances form between parties and individual voters. In addition, parties with compulsory voting battle for the votes of a separated subset of voters, something which is not observed in the voluntary mode.

More broadly, the present paper links greatly to a variety of important theoretical and empirical studies in the electoral competition literature, which accentuates its external validity. First, we show that a lasting divided society can emerge via pork barrel politics in spite of the absence of apparent "coordination devices" that more effectively facilitate long-standing alliances between parties and their supporters. For example, we do not use ideological preferences of voters such as in models of spatial competition (e.g., Dixit and Londregan 1996; Downs 1957; Hotelling 1929), other characteristics of voters (e.g., education and religion), costs related to policy changes, or opportunities to monitor voter behavior (e.g., Nichter 2008; Stokes 2005). In this regard, our experiment not only provides insights on short-term favors, but also on a more fundamental distributive process that contributes to shaping society in the long run. Second, observational evidence suggests that voters do indeed respond to political favors in ways consistent with our theoretical and experimental findings for the polity game with voluntary voting. Chen (2013) finds that government delivery of distributive aid raises turnout for the incumbent party and decreases turnout for the opposition. In our terminology, the aid increases preference intensities of incumbent supporters and decreases those of opponent supporters (and potentially turns them into incumbent supporters). As a consequence, because voters' preference intensities and positively associated with their probability of going to the polls, turnout rises for the incumbent party and falls for the opposition. Note that in Chen (2013) the distributive aid operates on an existing divide in the electorate (i.e., the Democratic and Republican divide in the U.S.), while in our experiment polarization is endogenous. Third, there is observational evidence that compulsory voting leads to less redistributive inequality than voluntary voting. In particular, Fowler (2013) shows that Australia's adaption of the compulsory mode markedly increased turnout and pension spending at the

national level, and hence yielded a public policy that considers the preferences of larger numbers of citizens. Moreover, higher levels of voter participation are associated with more equal distributions of income (e.g., Lijphart 1997; Mueller and Stratmann 2003). Finally, voluntary turnout patterns with respect to preference intensities and differences in supporter group sizes in our and other experimental studies (e.g., Großer and Schram 2010; Levine and Palfrey 2007) are very similar to those observed in the field (for surveys, see Blais 2000 and Matsusaka and Palda 1993). Thus, in strong support of the external validity of this paper, many of our findings are consistent with those of other empirical, more partial studies. In linking the various important studies on electoral competition, we believe that our study can help to obtain a more coherent picture of the general political process.

References

Abbink, Klaus, and Abdolkarim Sadrieh. 1995. "RatImage, Research Assistance Toolbox for Computer-Aided Human Behavior Experiments." Discussion Paper No. B-325, University of Bonn.

Alesina, Alberto. 1988. "Credibility and policy convergence in a two-party system with rational voters." *American Economic Review* 78 (4): 796-805.

Avrahami, Judith, and Yaakov Kareev. 2009. "Do the weak stand a chance? Distribution of resources in a competitive environment." *Cognitive Science* 33 (5): 940-50.

Axelrod, Robert. 1981. "The emergence of cooperation among egoists." *American Political Science Review* 75 (2): 306-18.

Baron, David P. 1991. "Majoritarian incentives, pork barrel programs, and procedural control." *American Journal of Political Science* 35 (1): 57-90.

Blais, André. 2000. *To vote or not to vote? The merits and limits of rational choice theory*. Pittsburgh PA: University of Pittsburgh Press.

Borel, Emile. 1921. "La théorie du jeu et les équations intégrales à noyau symétrique." *Comptes Rendus de l'Académie des Sciences* 173: 1304-08.

Brams, Steven J., and Morton D. Davis. 1974. "The 3/2's rule in presidential campaigning." *American Political Science Review* 68 (1): 113-34.

Campbell, Colin M. 1999. “Large electorates and decisive minorities.” *Journal of Political Econo my* 107 (6): 1199-1217.

Cason, Timothy N., and Vai-Lam Mui. 2005. “Uncertainty and resistance to reform in laboratory participation games.” *European Journal of Political Economy* 21, 708-37.

Chen, Jowei. 2013. “Voter partisanship and the effect of distributive spending on political participation.” *American Journal of Political Science* 57 (1): 200-17.

Chowdhury, Subhasish M., Dan Kovenock, and Roman M. Sheremeta. 2013. “An experimental investigation of Colonel Blotto games.” *Economic Theory* 52 (3): 833-61.

Corazzini, Luca, Sebastian Kube, Michel André Maréchal, and Antonio Nicoló. “Elections and deceptions: An experimental study on the behavioral effects of democracy.” *American Journal of Political Science*. Forthcoming.

Cox, Gary W., and Mathew D. McCubbins. 1986. “Electoral politics as a redistributive game.” *Journal of Politics* 48 (2): 370-89.

Diekmann, Andreas. 1985. “Volunteer’s dilemma.” *Journal of Conflict Resolution* 29 (4): 605-10.

Dixit, Avinash, and John Londregan. 1995. “Redistributive politics and economic efficiency.” *American Political Science Review* 89 (4): 856-66.

Dixit, Avinash, and John Londregan. 1996. “The determinants of success of special interests in redistributive politics.” *Journal of Politics* 58 (4): 1132-55.

Dixit, Avinash, and John Londregan. 1998. “Ideology, tactics, and efficiency in redistributive politics.” *Quarterly Journal of Economics* 113 (2): 497-529.

Downs, Anthony. 1957. *An economic theory of democracy.* New York: Harper and Row Publishers.

Feddersen, Timothy, Sean Gailmard, and Alvaro Sandroni. 2009. “Moral bias in large elections: Theory and experimental evidence.” *American Political Science Review* 103 (2): 175-92.

Feddersen, Timothy, and Alvaro Sandroni. 2006. “A theory of participation in elections.” *American Economic Review* 96 (4): 1271-82.

Fowler, Anthony. 2013. “Electoral and policy consequences of voter turnout: Evidence for compulsory voting in Australia.” *Quarterly Journal of Political Science* 8 (2): 159-82.

Goeree, Jacob K., and Charles A. Holt. 2005. "An explanation of anomalous behavior in models of political participation." *American Political Science Review* 99 (2): 201-13.

Gross, O. A., and R. A. Wagner. 1950. "A continuous Colonel Blotto game." Research Memorandum RM-408. Santa Monica: RAND Corporation.

Grossman, Gene M., and Elhanan Helpman. 2005. "Party discipline and pork barrel politics." Cambridge, MA: NBRR Working Paper 11396.

Großer, Jens, and Arthur Schram. 2010. "Public opinion polls, voter turnout, and welfare: An experimental study." *American Journal of Political Science* 54 (3): 700-17.

Großer, Jens, and Thorsten Giertz. 2009. "Candidates, voters, and endogenous group formation: A Colonel Blotto experiment." Working paper.

Großer, Jens, and Thorsten Giertz. 2014. "Indifferent voters and pork barrel politics: A Colonel Blotto experiment." Working paper.

Hart, Sergiu. 2008. "Discrete Colonel Blotto and general lotto games." *International Journal of Game Theory* 36 (3-4): 441-60.

Hotelling, Harold. 1929. "Stability in competition." *Economic Journal* 39 (153): 41-57.

Kreps, David M., Paul Milgrom, John Roberts, and Robert Wilson. 1982. "Rational cooperation in the finitely repeated prisoners' dilemma game." *Journal of Economic Theory* 27 (2): 245-52.

Laslier, Jean-François, and Nathalie Picard. 2002. "Distributive politics and electoral competition." *Journal of Economic Theory* 103 (1): 106-30.

Levine, David K., and Thomas R. Palfrey. 2007. "The paradox of voter participation? A laboratory study." *American Political Science Re*view 101 (1): 143-58.

Lijphart, Arend. 1997. "Unequal participation: Democracy' unresolved dilemma." *American Political Science Review* 91 (1): 1-14.

Lizzeri, Alessandro. 1999. "Budget deficits and redistributive politics." *Review of Economic Studies* 66 (4): 909-28.

Lizzeri, Alessandro, and Nicola Persico. 2001. "The provision of public goods under alternative electoral incentives." *American Economic Review* 91 (1): 225-39.

Lizzeri, Alessandro, and Nicola Persico. 2005. "A drawback of electoral competition." *Journal of the European Economic Association* 3 (6): 1318-48.

Matsusaka, John G., and Filip Palda. 1993. "The Downsian voter meets the ecological fallacy." *Public Choice* 77(4): 855-78.

McKelvey, Richard D., Andrew McLennan, and Theodore L. Turocy. 2013. "Gambit: Software Tools for Game Theory, Version 14.0.1." http://www.gambit-project.org.

McKelvey, Richard D., and Thomas R. Palfrey. 1995. "Quantal response equilibria for normal form games." *Games and Economic Behavior* 10 (1): 6-38.

McKelvey, Richard D., and Peter C. Ordeshook. 1990. "A decade of experimental research on spatial models of elections and committees." In *Government, democracy, and social choice*, ed. Melvin J. Hinich and James M. Enelow. Cambridge: Cambridge University Press.

Mueller, Dennis C., and Thomas Stratmann. 2003. "The economic effects of democratic participation." *Journal of Public Economics* 87 (9-10): 2129-55.

Myerson, Roger B. 1993 "Incentives to cultivate favored minorities under alternative electoral systems." *American Political Science Review* 87 (4): 856-69.

Nichter, Simeon. 2008. "Vote buying or turnout buying? Machine politics and the secret ballot." *American Political Science Review* 102 (1): 19-31.

Owen, Guillermo. 1968. *Game theory.* Philadelphia: W.B. Saunders.

Palfrey, Thomas R., and Jeffrey E. Prisbrey. 1997. "Anomalous behavior in public goods experiments: How much and why?" *American Economic Review* 87 (5): 829-46.

Palfrey, Thomas R., and Howard Rosenthal. 1983. "A strategic calculus of voting." *Public Choice* 41 (1): 7-53.

Persson, Torsten, and Guido Tabellini. 2000. *Political economics: explaining economic policy*. Cambridge, MA: MIT Press.

Roberson, Brian. 2006. "The Colonel Blotto game." *Economic Theory* 29 (1): 1-24.

Sankoff, David, and Koula Mellos. 1972. "The swing ratio and game theory." *American Political Science Review* 66 (2): 551-54.

Schram, Arthur, and Joep Sonnemans. 1996. "Voter turnout as a participation game: an experimental investigation." *International Journal of Game Theory* 25 (3): 385-406.

Snyder, James M. 1989. "Election goals and the allocation of campaign resources." *Econometrica* 57 (3), 637-60.

Stokes, Susan C. 2005. "Perverse accountability: A formal model of machine politics with evidence from Argentina." *American Political Science Review* 99 (3): 315-25.

Stokes, Susan C. 2009. "Pork by any other name … Building a conceptual scheme of distributive politics." Working paper: Yale University.

Young, H. Peyton. 1978. "The allocation of funds in lobbying and campaigning." *Behavioral Science* 23 (1), 21-31.

Online Supporting information

See https://sites.google.com/site/jwghome/research