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Public Opinion Polls, Voter Turnout, and Welfare: An Experimental Study

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Public opinion polls, voter turnout, and welfare: An experimental study*

by

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Abstract

We experimentally study the impact of public opinion poll releases on voter turnout and welfare in a participation game. We find higher turnout rates when polls inform the electorate about the levels of support for various candidates than when polls are prohibited. Distinguishing between allied and floating voters, our data show that this increase in turnout is entirely due to floating voters. Very high turnout is observed when polls indicate equal support levels for the candidates. This has negative consequences for welfare. Though in aggregate social welfare is hardly affected, majorities benefit more often from polls than minorities. Finally, our comparative static results are better predicted by quantal response (logit) equilibrium than by Bayesian Nash equilibrium.

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1. INTRODUCTION

In many countries public opinion polls provide the electorate with information about voter preferences in upcoming elections. In contrast, about equally many countries prohibit the release of such information in a given period prior to Election Day.[1] Neither policy can claim a clear foundation in scientific research: "After at least 60 years of research, a rich literature has developed concerning the question 'do polls influence behavior?'. Yet no conclusive or unambiguous answer to the question can be given, whether related to vote choice, turnout, or opinions on issues" (Irwin and Van Holsteyn 2000, p. 22). Consequently, policy makers cannot adequately evaluate the effects of public opinion poll releases on social welfare.

This paper uses game theory and laboratory experiments in an attempt to overcome this gap in our knowledge. In two-candidate majoritarian elections with costly turnout we compare electorates where the voters' idiosyncratic preferences are kept secret to electorates where these are revealed before elections. In the latter case, a poll provides perfectly accurate information about the level of support for each candidate.[2] These levels of support determine the 'level of disagreement' in the electorate. Disagreement is high if both candidates receive similar levels of support and low if most voters prefer the same candidate (Feddersen and Sandroni 2006).[3] In analyzing the effects of polls we need to take the actual level of disagreement into account because the effect of information may depend on it.

For any given level of disagreement the release of polls may make (some) voters change their turnout decision. This has two potential welfare effects. First, changes in turnout have a direct influence because they change the electorate's aggregate costs of voting. For example, higher turnout decreases welfare because it yields increased aggregate voting costs (Palfrey and Rosenthal 1983; Ledyard 1984). Second, welfare may be affected by changes in turnout because the candidates' probabilities of winning may change. Here, we assume that the electorate's aggregate benefits are larger if the candidate preferred by a majority of voters wins.[4] For example, if higher turnout (e.g., induced by a poll release) increases the majority-

[1] For 2002, a survey of 66 countries shows that 36 have no embargo on poll releases and 30 ban publication in a period ranging from a day to a month before elections (Foundation for Information/ESOMAR/WAPOR 2003).

[2] We provide perfect information to avoid unnecessary noise in our experiment. In practice, so-called 'trial-heat polls' become increasingly more informative about the election outcome (and thereby reduce such noise) in the course of a campaign (Erikson and Wlezien 1996; Brown and Chappell 1999; Campbell 1996).

[3] For example, there is currently high disagreement within the U.S. electorate, which has become increasingly polarized over the past three decades (McCarty, Poole, and Rosenthal 2006), culminating in astonishingly close presidential elections in 2000 and 2004. In contrast, the alleged low disagreement within the Polish electorate was confirmed when 77.5% voted 'yes' to the country's entry to the EU in 2003.

[4] This assumption holds, for example, if each voter's benefits from her or his preferred candidate winning is the same (and the same holds for losing). In that case, aggregate benefits are highest if the candidate supported by a majority wins. Since the aggregation of individual well-being is beyond the scope of our paper, we only

preferred candidate's chances, this increases welfare. Of course, whether changes in turnout have a positive or negative effect on the majority's chances depends on *how* polls change the decisions to vote. If the influence of polls on these decisions is independent of voter's preferences, turnout affects the majority's chances (thus, the electorate's aggregate benefits) positively. However, such independence is not obvious. If polls change the relative turnout between two supporter groups in favor of the minority, the majority's chances may decrease.[5] Whether the release of public opinion polls ultimately increases or decreases welfare as a combined result of changes in aggregate voting costs and benefits is an important theoretical and empirical question. Our model and laboratory control allow us to answer this question by systematically examining and separating the various effects of polls on turnout and welfare.

An important way in which polls may effect the decision to vote is through the information they convey about the 'closeness' of an election. In the rational choice model of Downs (1957), for example, this information may change a voter's expectation of her or his vote being pivotal, where the pivot probability increases with the level of disagreement in the electorate. The Downsian voter will vote if the expected benefits exceed the voting costs. A change in perception of the level of disagreement (thus, the pivot probability) induced by polls changes expected benefits and, hence, may affect turnout in these models (e.g., Brown and Zech 1973; Zech 1975; and Gärtner 1976). Field studies have supported this relationship (that turnout increases in fierce races) by considering the '*ex post*' closeness of elections –i.e., closeness based on actual votes cast– as a proxy for the level of disagreement (e.g., Matsusaka and Palda 1993). In contrast, our experiment allows us to control for the true '*ex ante*' level of disagreement in the electorate –i.e., closeness based on the electorate's preferences– to examine this relationship. Note that the ex ante level of disagreement is difficult to estimate in the field, whereas it is precisely known in the laboratory.

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consider this case. For examples where benefits vary across voters and welfare may not be higher if the majority-preferred candidate wins see Campbell (1999); or Großer and Giertz (2006).

5 For example, polls that indicate a lower level of disagreement than anticipated may stimulate turnout in the minority more than in the majority, where free rider incentives are stronger (cf. also Goeree and Großer 2007; Taylor and Yildirim 2006). In this way changes in voter turnout may negatively affect the majority-preferred candidate's chances and thereby decrease welfare. Lohmann (1994) shows that negative welfare effects may also result from biased aggregate information through costly pre-election political action. In Börgers (2004), the electorate's preferences are revealed 'ex post' through compulsory voting (which maximizes the benefits). However, welfare decreases as compared to voluntary voting because of the excessive turnout costs. Krasa and Polborn (2006) use the model of Börgers to allow for subsidized turnout and show that increasing turnout does generally increase welfare, if the electorate is sufficiently large (as in Xu 2002). Finally, based on empirical observations Lijphart (1997) concludes that welfare increases with turnout by arguing that *low* turnout is a 'serious problem' because it involves *unequal* turnout (e.g., the poor vote less than the rich).

An often-made distinction among voters that may change the impact of poll releases on turnout is that between *allied* voters with stable preferences across legislative periods and *floating* voters who decide on the candidate to support on a case-by-case basis.[6] In fact, the substantial uncertainty about the electorate's level of disagreement caused by floating voters is a main reason for pollsters to conduct public opinion polls in the first place. The importance of these voters for election outcomes has long been recognized (e.g., Lazarsfeld et al. 1948; Berelson et al. 1954; Campbell 1960; Daudt 1961; Converse 1966; Key 1966) and is still under investigation (Zaller 2004). Observe that allied and floating voters may respond differently to information in polls (e.g., the attachment of allied voters to their group may override this information). Our model and data allow us to empirically investigate this. Moreover, we will compare the effects of polls in electorates with only floating voters to those with both allied and floating voters.

The literature on public opinion polls and voter behavior (e.g., Simon 1954; for a valuable survey see Irwin and van Holsteyn 2000) has typically focused on the effect of polls on *candidate choice* (e.g., McKelvey and Ordeshook 1984, 1985, 1987; Forsythe et al. 1993; Myerson and Weber 1993; Fey 1997). In contrast, we assume *fixed* preferences because our interest lies in the effect of polls on the *turnout decision*. The participation game of Palfrey and Rosenthal (1983, 1985) provides a suitable framework for this purpose. This game (to be described in detail below) was also used to theoretically study the effect of polls on voter turnout and welfare by Goeree and Großer (2007) and Taylor and Yildirim (2006) as well as to investigate the effects of other types of information by Diermeier and van Mieghem (2005) and Großer and Schram (2006). To the best of our knowledge, we are the first to theoretically and experimentally investigate uncertainty about the level of disagreement and its resolution through poll releases using the participation game framework. In a related experimental study, Levine and Palfrey (2007) systematically test the game's predictions with cost uncertainty for two different levels of disagreement under varying electorate sizes. They show that the Bayesian Nash equilibrium can explain the comparative statics very well but that quantal response equilibrium improves the data fit. They do not study the effects of poll

[6] For example, in 2004 the pollster Populus categorized 35% of the UK electorate as floating voters (Times Online, 07.09.2004, "Boost for Kennedy as Blair and Howard slip"). Note that the terms 'floating' and 'swing' voters are often used interchangeably. We use the term 'floating' to avoid confusion with swing voters in the 'swing voter's curse' (Feddersen and Pesendorfer 1996).

releases on voter turnout and welfare, however. We will compare our results to this study, where appropriate.[7]

The laboratory allows us to control for variables that are not the primary focus of investigation, but are difficult to correct for in field studies. For example, in our experiment we hold the electorate size, voting costs, and benefits from election outcomes constant. We then systematically vary the variables of interest such that conclusions can be drawn from comparative statics under best possible ceteris paribus conditions. Specifically, we investigate turnout and welfare by varying one at a time (i) the level of disagreement within the electorate and (ii) whether or not polls inform subjects about this level before elections. Moreover, the laboratory allows us to create voter alliances by (iii) keeping the preferred candidate of allied voters constant across elections. These are distinguished from floating voters who may switch from one to the other candidate between elections. In this way, we can study the effect of the stability of preferences on turnout and welfare, and make a comparison between both voter types.

2. PARTICIPATION GAMES

To study the effects of poll releases on turnout and welfare we use a combined analysis of Palfrey and Rosenthal's participation game with complete information (1983, henceforth PR83) and with incomplete information about the electorates' preferences (1985, henceforth PR85).[8] The situation we model is where the candidate preferences of some voters are private information unless pollsters publish them in the run-up to elections. A formal description of the model is presented in an online appendix.[9]

In the participation game there are two exogenous candidates, *A* and *B*, and each voter in an electorate of size *E* supports one of the two. We denote the numbers supporting each candidate by N_A and N_B, respectively, where $N_A + N_B = E$. Each voter individually and privately decides between voting at a cost $c > 0$ and abstaining (without costs). The candidate who receives more votes wins the election (ties are broken by a coin toss) and each supporter of this candidate receives an equal reward, independent of whether or not he or she

[7] Klor and Winter (2007) provide a useful follow-up to our study by using slight variations in the experimental design and parameters in order to better compare their data with original field data. They do not take allied voters into account, however. Their experimental results essentially confirm our results. An important difference is that they rely on subjects' reported beliefs of being pivotal (cf. Duffy and Tavits 2007).

[8] Alternatively, Myerson (1998) models the participation game as a Poisson game with uncertainty about the size of the electorate. He shows that for large electorates both the participation game with complete information (PR83) and with incomplete information (PR85) can be approximated by a Poisson game. For the purpose of our experimental study, the original participation game is more suitable than the Poisson game.

[9] See ________ (add website).

voted. Supporters of the defeated candidate receive smaller rewards, thus, aggregate benefits are larger if the majority-preferred candidate wins. Whereas in PR83 the electorate's preferences are common knowledge, voters only know a common probability distribution of these preferences in PR85.[10] The (Bayesian) Nash equilibria and quantal response equilibria, both of which specify turnout probabilities, can easily be derived for these games (cf. the online appendix). Consequently, each candidate's winning probability and the expected welfare in equilibrium can be derived. Specific predictions for our experimental parameters are given in the following sections. We focus on totally quasi-symmetric mixed strategy equilibria (cf. PR83), in which all voters facing the same decision making situations have the same voting probability (strictly between zero and one).

To understand how *relative* turnout probabilities between groups affect welfare, it is helpful to look at the participation game's two inherent conflicts. First, the *inter*-group conflict for the higher rewards stimulates turnout in pivotal situations. Second, the *intra*-group conflict to free ride on costly votes by others in the own group suppresses turnout in non-pivotal situations. Note that a single vote is either pivotal if there is one vote less by co-supporters than by the other group (i.e., it can create a tie) or if there are equally many votes in the two groups (i.e., it can break a tie). All other situations are non-pivotal. In the totally quasi-symmetric mixed strategy equilibrium each voter in the electorate has the same pivot probability, because it is determined exogenously by the cost-benefit ratio.[11] For any given turnout probability of voters in the other group, the intra-group incentive to abstain is increasing in the own group size (as in Olson 1965). As a consequence, polls indicating lower levels of disagreement than anticipated yield stronger incentives to abstain in the larger than in the smaller group. *Ceteris paribus*, this may change relative (equilibrium) turnout probabilities in favor of the minority-preferred candidate and increase her or his chances in the election. This is indeed the case in the Nash equilibrium (but not the quantal response equilibrium) for our experimental parameters.

To accommodate the possibility of allied voters in the participation game, we need to modify it such that we have

[10] In PR85 there is also incomplete information about others' costs of voting, which allows for Bayesian Nash equilibria in cutoff strategies. Because our focus is on the resolution of preference uncertainty through polls, we avoid confronting subjects in the laboratory with additional sources of uncertainty and use constant costs and benefits across voters.

[11] Specifically, the pivot probability is equal to two times the costs, divided by the net benefits from the preferred candidate winning (cf. PR83 and the online appendix).

(a) an (equal) minimal group size, $\underline{N}_i \geq 1$, for each group $i = A, B$, implying a maximal group size of $E - \underline{N}_i$, and

(b) a discrete probability distribution over all possible electoral compositions (N_i, N_{-i}), $i \neq -i$, from the set $\{(\underline{N}_i, E-\underline{N}_i), (\underline{N}_i + 1, E - \underline{N}_i - 1), ..., (E - \underline{N}_i, \underline{N}_i)\}$, with $prob(.,.) > 0$ for each element in the set.

To allow for our distinction between allied and floating voters, a repeated setting is needed, where the allied voters in the minimal groups stay together for all elections, without changing preferences. In contrast, the preferences of floating voters are randomly drawn anew before each election. Note that this distinction as such does not depend on whether or not poll results are published.

There is a small literature studying the participation game experimentally. This includes studies on the effects of group and electorate sizes (Rapoport and Bornstein 1989; Schram and Sonnemans 1996a; Hsu and Sung 2002; Großer and Giertz 2006; Levine and Palfrey 2007); the subjective probability of being pivotal (Duffy and Tavits 2007; Klor and Winter 2007); proportional representation vs. winner-takes-all elections (Schram and Sonnemans 1996a); different tie breaking rules (Bornstein, Kugler, and Zamir 2005); group identification and communication (Bornstein and Rapoport 1988; Bornstein 1992; Schram and Sonnemans 1996b); reward uncertainty (Cason and Mui 2005) and cost uncertainty (Levine and Palfrey 2007). Others extend the model to allow for endogenous information about other voters' turnout (Großer and Schram 2006) and endogenous policy making and group formation (Großer and Giertz 2006). In all these experiments, relatively high turnout is observed, albeit lower than in most general elections around the world. Except for the experiment with cost uncertainty (Levine and Palfrey 2007) the standard (Bayesian) Nash equilibrium concept finds little empirical support. However, Goeree and Holt (2005), Cason and Mui (2005), and Levine and Palfrey (2007) show that quantal response equilibrium can account for the data in many cases. Contrary to (Bayesian) Nash, quantal response equilibrium predicts substantial turnout (in the order of 50%) in large elections with imperfectly rational voters (Levine and Palfrey 2007).

3. EXPERIMENTAL DESIGN

PROCEDURES AND TREATMENTS

The computerized[12] experiment was run at the laboratory of _______. 288 undergraduate students were recruited in 12 sessions of 24 subjects. Each session lasted about 2 hours (cf. the online appendix for the read-aloud instructions). Earnings in the experiment were expressed in tokens. At the end of a session, token earnings were transferred to cash at a rate of 4 tokens to one Dutch Guilder. Subjects earned an average of 56.01 Dutch Guilders (≈ € 25.42).

In each session, the 24 subjects were randomly divided into two electorates of $E = 12$ voters. Each electorate consisted of two groups $i = A, B$. There was no interaction of any kind between subjects in different electorates, and this was known to all of them. Given that we do not know the structure of the correlations across observations, we treat the electorate as the only independent unit of observation. Hence, each session provides us with two independent observations.

We employed a full 2×2 between subject treatment design with three sessions (six electorates) per cell. Our first treatment variable manipulated the *information* about the realized level of support for each candidate. This information was either given at the beginning of each round ('informed', i.e. a poll is released) or not at all ('uninformed', i.e. no poll is released). Our second treatment variable manipulated *voter alliances*. In one treatment ('floating') there were only floating voters, while in the other ('mixed') there were 3 allied voters in each group plus 6 floating voters. Throughout, each subject was either an allied or floating voter and knew her or his type right from the start. Note that floating voters were always reallocated within the same electorate.

PREFERENCE UNCERTAINTY

Information and voter alliance were both varied between subjects. To create the possibility of preference uncertainty, we varied the level of disagreement within subjects. In any given round, each group consisted of a minimum of $\underline{N}_i = 3$ voters and a maximum of 9. Any integer group size $N_A, N_B \in \{3,4,...,9\}$, where $N_A + N_B = E$, was possible. This means that the level of disagreement was highest when each of the two supporter groups consisted of 6 voters and lowest when a minority of 3 voters faced a majority of 9. We will represent the

[12] The experimental software was programmed using RatImage (Abbink and Sadrieh 1995).

level of disagreement by the size of the minority. Note that this level indeed increases as the minority does so.

The randomization used to determine group sizes proceeds in the following two steps:

- Step 1: 3 subjects were allocated to each group. Each subject in the electorate had an equal chance of being chosen for either group.
- Step 2: The remaining 6 subjects were independently and randomly allocated, with equal probability for each group.

This procedure was known to all subjects. The way it was applied is different for our 'floating' and 'mixed' treatments. In 'floating' sessions, both steps were performed at the beginning of each round and, importantly, subjects did not know at which step they were allocated to the groups. In 'mixed' sessions, step 1 determined the 6 subjects to take the role of allied voters and their group allocation. This step was performed only once, at the beginning of the first round, while step 2 reallocated the 6 floating voters at the beginning of each round. Notice that step 2 produces a binomial distribution of group sizes with $p = 0.5$, where electoral composition (6,6) occurs with probability .3125, (5,7) and (7,5) each with .2344, (4,8) and (8,4) each with .0938, and (3,9) and (9,3) each with .0156.

Each session consisted of 100 decision rounds.[13] The electoral composition was varied in a random, but predetermined manner across rounds (see the online appendix for the complete sequence). 33 rounds used the composition (6,6), 23 used (5,7), 22 used (7,5), 9 used (4,8), 9 used (8,4), 2 used (3,9), and 2 used (9,3). Whether subjects knew the actual levels of support in each group when making their decisions depends on the information treatment. In the 'informed' sessions, the actual 'own' and 'other' group's levels of support were announced at the beginning of each round, while in the 'uninformed' sessions these were never released.[14] Hence, subjects in 'uninformed' faced the same decision problem in each round.[15]

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[13] Due to a computer crash, one session had to be stopped after 94 rounds.

[14] Groups were labeled 'own' and 'other' to avoid floating voters associating with either group.

[15] However, 'uninformed' allied and floating voters have different information about the level of disagreement. An allied voter knows that there are at least 3 (at most 9) voters in each group. A floating voter, on the other hand, knows that there are at least 4 voters in her or his own group and at most 8 in the other. As a consequence, in the 'mixed' treatment allied voters have an expected 'own' group size of 6, whereas for floating voters Bayesian updating yields an expected 'own' group size of 6.5. When there are only floating voters, this expectation is 6.25.

PAYOFF PARAMETERS

In each round, each voter of the winning group received 4 tokens and each voter of the defeated group received 1 token. As the cost of turnout was 1 token (independent of a subject's type), negative payoffs were avoided. Table 1 summarizes treatments and parameters.

TABLE 1: SUMMARY OF TREATMENTS AND PARAMETERS

Treatment	*Acronym*	*# Floating voters*	*# Allied voters*	*Poll release*
Uninformed Floating	UF	12	0	No
Uninformed Mixed	UM	6	6	No
Informed Floating	IF	12	0	Yes
Informed Mixed	IM	6	6	Yes

Notes: All treatments had 100 rounds and electorates of 12 voters, with a minimum (maximum) of 3 (9) in each group. A victory (defeat) payed 4 (1) to each voter in the group and the individual costs of voting were equal to 1. We have observations from 6 independent electorates per treatment.

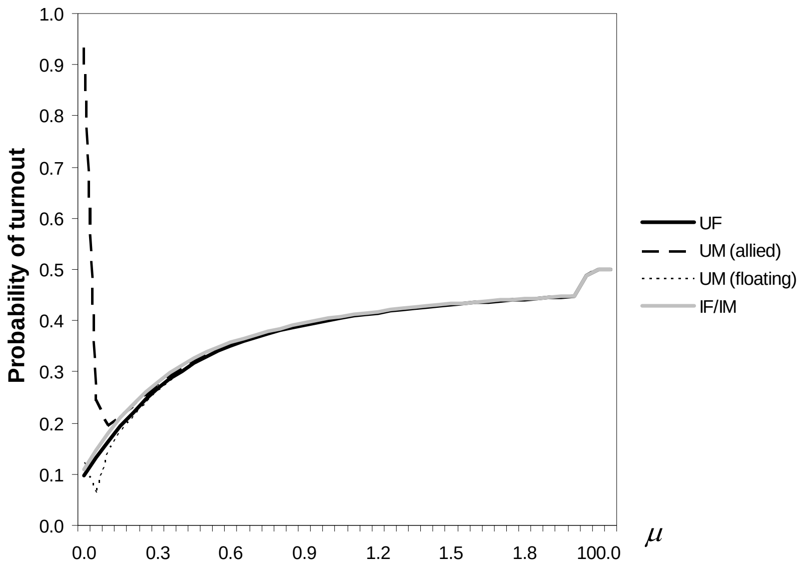
4. EQUILIBRIUM PREDICTIONS

For the parameters of our experiment, we can numerically derive (Bayesian) Nash equilibria in totally quasi-symmetric mixed strategies as well as quantal response equilibria (McKelvey and Palfrey 1995). The latter are characterized by a non-negative 'noise' parameter μ.[16] The (Bayesian) Nash equilibrium is a limit case of the quantal response equilibrium for $\mu = 0$. At the other extreme, when $\mu \to \infty$ the equilibrium probability of voting approaches 0.5, which represents purely random behavior. Our equilibrium analysis is described in detail in the online appendix, using the logit specification of the quantal response equilibrium ('logit equilibrium'; McKelvey and Palfrey 1995). Here, we first present aggregate turnout probabilities for our experimental parameters in the various equilibria. We continue by giving comparative static equilibrium predictions of turnout probabilities across levels of support and disagreement; probabilities of winning; and expected welfare. The quantitative predictions for these variables of interest are postponed until the following sections, where they will be directly compared to the data.

[16] We have also derived pure strategy (Bayesian) Nash equilibria. However, these do not provide us with testable predictions about our treatment effects and, hence, are only briefly described here. In the 'informed' treatments (IF and IM), full turnout is the pure strategy equilibrium when both candidates have equal levels of support of 6. For all asymmetric pairs of support levels, there is no pure strategy equilibrium. In the 'uninformed' treatments (UF and UM) there is no pure strategy Bayesian Nash equilibrium with full turnout. For UF the only Bayesian Nash equilibria in pure strategies are those, where one voter of either group votes and all others abstain. No Bayesian Nash equilibria in pure strategies exist for UM.

Figure 1 gives the equilibrium probabilities of turnout per treatment as a function of the noise level μ. For the informed treatments (IF and IM) these probabilities are aggregated as weighted averages of the probabilities for the distinct levels of support used in our experiments. For these treatments information is exactly the same for all voters at the time of the election so we show one aggregate turnout probability. We show separate turnout probabilities for allied and floating voters in 'uninformed' (UF and UM) where slight differences may occur between them in the expected levels of disagreement (cf. footnote 19).

FIGURE 1: EQUILIBRIUM TURNOUT PER TREATMENT



Notes: The lines give the logit equilibria for varying μ from 0 to 2 and the discrete cases 10, 100, and 1000 (which show up as a 'jump' upwards, with turnout probabilities close to 0.5). Where distinct lines can no longer be visually separated, one line represents all.

In the Bayesian Nash equilibrium ($\mu = 0$) for the uninformed treatments, average expected turnout is substantially higher when there are allied and floating voters (53% in UM) than when all voters are floating (10% in UF). The latter turnout is close to the Nash equilibrium for the informed treatments (11%). The high turnout in UM is entirely due to the very high turnout probability of allied voters (94%). In contrast, the 12% voting probability for floating voters in UM is similar to the other treatments.

When noise is introduced the equilibrium predictions across treatments quickly converge. From a noise level of approximately $\mu = 0.3$ upwards, equilibrium turnout probabilities are virtually identical across voter types and treatments. These logit equilibria are increasing in μ. Note that for these noise levels they give qualitatively different predictions than (Bayesian) Nash equilibrium. In particular, except for allied voters in UM higher turnout is predicted than in the (Bayesian) Nash equilibrium. A noise level of 0.3 lies below the levels reported for previous participation game experiments. *E.g.*, Goeree and Holt (2005) estimate $\mu = 0.8$ in early rounds and $\mu = 0.4$ in later rounds for the Schram and Sonnemans (1996a) data with symmetric group sizes of 6 and costs and benefits similar to our parameters. Hence, we will use the turnout probabilities for $\mu \geq 0.3$ for our logit predictions.

Consequently, in the following we use (Bayesian) Nash equilibrium ($\mu = 0$) and logit equilibrium for $\mu \geq 0.3$ to derive qualitative *theoretical results* (TR) relevant to our experiments.[17] These equilibria specify turnout probabilities (disaggregated per level of support) and we can use them to derive equilibrium predictions for winning probabilities and expected welfare as well. We do so in aggregate and as well as per level of support and per level of disagreement. By comparing the equilibria for uninformed and informed electorates, we can establish the predicted effects of poll releases. Confronting our TR with our experimental results will allow us to determine which equilibrium concept provides better comparative statics, thus, better predicts the welfare consequences of polls. To do so, we present each TR in two parts: the Bayesian Nash prediction (assuming no noisy behavior) and the logit equilibrium prediction (assuming a noise level larger than 0.3).

TR1 (aggregate turnout): (i) In the absence of noisy behavior, polls do not affect aggregate expected turnout when there are only floating voters but substantially decrease it when there are both allied and floating voters. (ii) With noisy behavior, polls do not affect aggregate expected turnout.

TR2 (turnout per level of support): (i) Without noisy behavior, majority voters turn out less than minority voters but turnout probabilities are equal across support levels for uninformed electorates. When there are only floating voters, polls raise turnout in the minority and decrease it in the opposing majority. When there are allied and floating voters, the predicted turnout for the uninformed is high, so that polls substantially decrease turnout for all levels of support. (ii) When behavior is noisy, turnout probabilities are somewhat higher in the minority than in the opposing majority but highest for average support levels. Because all uninformed voters have a (same) predicted turnout in between the levels predicted for the informed, polls increase turnout probabilities for average levels of support and decreases it for relatively small or large levels.

[17] Due to imperfect monitoring after elections (voters only observe aggregate turnout) there may also be 'private sequential equilibria' (Mailath, Matthews, and Sekiguchi 2002). For our setting it is infeasible to compute such repeated game equilibria, however.

TR3 (turnout per level of disagreement): (i) In the absence of noisy behavior, expected turnout slightly decreases in the level of disagreement in informed electorates. Once again, (for obvious reasons) turnout of the uninformed is not predicted to be affected by the level of disagreement. The predicted turnout for uninformed is such that polls (slightly) increase expected turnout for all levels of disagreement when there are only floating voters and decrease it for all levels when there are allied and floating voters. (ii) With noisy behavior, expected turnout increases in the level of disagreement in informed electorates. Polls increase expected turnout for high levels of disagreement and decrease it for low levels, irrespective of the presence of allied voters.

TR4 (winning probabilities): (i) Without noisy behavior, the majority-preferred candidate in informed electorates has a lower chance to win than the minority candidate. This perhaps somewhat surprising result is due to the higher free-riding incentives in larger groups. The difference between the majority and minority is decreasing in the level of disagreement (i.e., in close elections the chances are more or less equal). The majority-preferred candidate always has better chances in uninformed electorates (where everyone of the same type votes with the same probability). This advantage is strongly increasing in the level of support, and even more so when there are allied voters. As a consequence, polls decrease the majority-preferred candidate's probability of winning for all levels of disagreement. (ii) In the presence of noisy behavior, the majority-preferred candidate always has better chances in the election than the minority opponent and this advantage strongly increases in the level of support in both informed and uninformed electorates. Polls somewhat diminish this advantage of the majority-preferred candidate for all levels of disagreement.

TR5 (social welfare): (i) When behavior is not noisy, expected social (or aggregate) welfare increases in the level of disagreement in all cases, but most strongly so for informed electorates. This is a natural consequence of TR4. It is bad for welfare if the minority wins and the probability of this happening is largest for low levels of disagreement. For uninformed electorates expected welfare is low for all levels of disagreement when there are allied voters (due to their expected high, costly turnout). When there are only floating voters, polls decrease expected welfare for all levels of disagreement. When there are allied and floating voters polls increase expected welfare for most levels of disagreement. (ii) When behavior is noisy, polls have little effect on expected social welfare, which is a U-shaped function of the level of disagreement in all informed treatments.

5. EXPERIMENTAL RESULTS

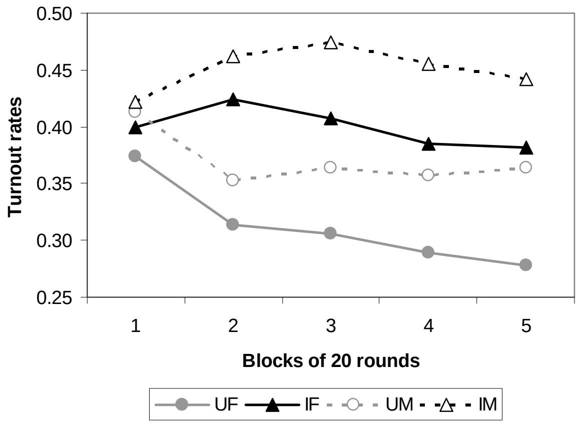
The presentation and analysis of our experimental results is organized as follows. We start by discussing observed effects of polls on turnout rates in aggregate and per level of support and disagreement (5.1). Thereafter, we investigate turnout rates per voter type (5.2). Then, we examine winning probabilities (5.3) and welfare (5.4). Many of our statistical tests are based on nonparametric statistics as described in Siegel and Castellan, Jr. (1988). For the reasons mentioned above, these tests are conducted at the electorate level (qualitative conclusions are based on one-tailed tests). In addition, random effects probit estimations are used to analyze turnout behavior at the individual level. To provide a benchmark for our data, we will frequently provide the specific (Bayesian) Nash predictions and logit predictions for the cases concerned.[18] Laboratory findings are summarized as *experimental results* (ER).

5.1 POLLS AND TURNOUT

Aggregate turnout

Figure 2 shows turnout rates averaged over blocks of 20 rounds each.

FIGURE 2: AGGREGATE TURNOUT RATES



Notes: UF=uninformed electorates with only floating voters; IF=informed electorates with only floating voters; UM=uninformed electorates with allied and floating voters; IM=informed electorates with allied and floating voters.

[18] These are the predictions underlying figure 1 and TR1-TR5. The online appendix gives a table providing a full overview of the equilibria per treatment, using $\mu = 0.4$ and 0.8 for the logit equilibria.

We observe higher rates when electorates are informed about the levels of support than when they are not. This holds for all blocks of rounds: the turnout rate is always higher in IF than in UF and higher in IM than in UM. Though all treatments start at similar levels, a difference of approximately 10%-points exists between informed and uninformed electorates from the second block onward for both comparisons.

ER1: *Polls increase turnout levels by 22-28%.*

SUPPORT. Wilcoxon-Mann-Whitney tests reject the null hypothesis of no difference in average turnout in favor of higher rates for informed electorates at the 5% significance level for the IF-UF comparison and at the 10% level for IM-UM. The increase in turnout is approximately 28% when all voters float and 22% when there are allied voters.

We can compare this result to TR1. ER1 clearly rejects the (Bayesian) Nash prediction in TR1 (i) that polls decrease aggregate turnout in electorates with allied and floating voters; in fact, the reverse holds. Note, however, that turnout levels are much closer to those derived by logit equilibrium for $\mu \geq 0.3$ than to those by the (Bayesian) Nash equilibrium (cf. figures 1 and 2). Specifically, the Bayesian Nash prediction of 10% turnout for UF (53% for UM) is much lower (higher) than the 31% (37%) observed, and the Nash predictions of 11% in both IF and IM are much smaller than the observed 40% and 45%, respectively. In comparison, the logit predictions using $\mu = 0.4$ ($\mu = 0.8$) lie for all treatments between 30% and 31% (38% and 39%) and are much closer to our observations. Hence, aggregate turnout can be better explained by the logit equilibrium than the (Bayesian) Nash equilibrium, though the logit equilibrium underestimates the increase in aggregate turnout caused by poll releases.

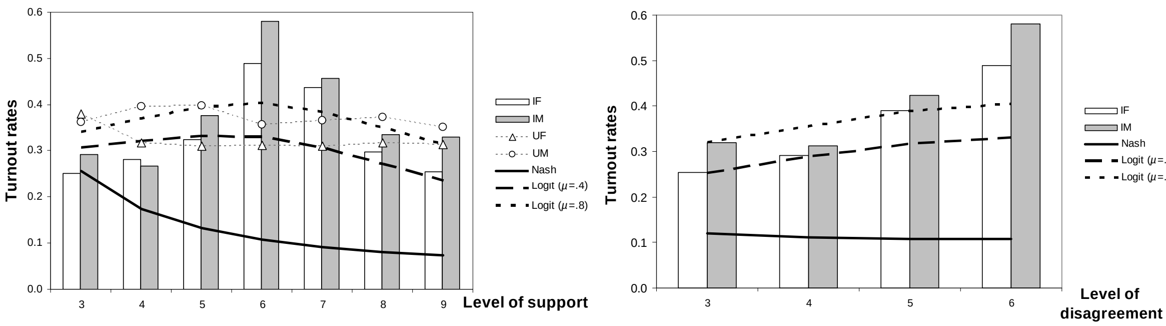
Turnout per levels of support and disagreement

Figure 3 shows turnout rates per level of support (left panel) and level of disagreement (right panel).

FIGURE 3: TURNOUT RATES

LEVEL OF SUPPORT

LEVEL OF DISAGREEMENT



Notes: The bars in both figures show turnout rates for informed electorates per level of support (left panel) and per level of disagreement (right panel). In the left panel, the lines with markers give turnout levels for uninformed electorates. The remaining lines show for informed electorates our Nash predictions and logit predictions for noise levels $\mu = 0.4$ and 0.8. The level of disagreement is measured by the size of the minority.

For the uninformed treatments (UF and UM), there is no reason to expect turnout to vary across levels because subjects do not know the electorate's actual preferences. This is confirmed in the left panel. For the informed treatments (IF and IM), figure 3 (right panel) shows that turnout generally increases in the level of disagreement. The left panel reveals that this holds for both the minority and majority (because turnout decreases as one moves away from group size 6 in either direction).[19] Moreover, a comparison of turnout left and right of the median group size in the left panel shows that turnout is always lower in the minority than in the corresponding majority. Finally, observe the very high turnout rates of 49% in IF and 58% in IM for the highest disagreement level; the former can only be only justified by the logit equilibrium for unreasonably high noise levels and the latter cannot be explained by any of our equilibria (cf. figure 1).

A first general conclusion about the effect of polls on turnout per level of support can be derived from figure 3. This is that polls increase turnout for intermediate group sizes and decrease turnout for small or large groups. For a more detailed analysis of the effects of poll releases on voter turnout we consider the effect at the individual level, using random effects probit estimations. More specifically, we estimate a panel model explaining the individual decision to vote or abstain for each of our four treatments separately. As explanatory variables we consider the various levels of support a voter is confronted with (which can only affect behavior in our informed treatments), a time trend, and a set of lagged variables. The latter include the own previous turnout decision and indicators of situations where the voter concerned had been pivotal (*ex post*) in the previous round. Note that if subjects use totally quasi-symmetric mixed strategies, their turnout decisions should not be affected by past events. We distinguish between allied and floating voters in our mixed treatments.

[19] The only exception to these observations is found when moving from group size 3 to 4 in IM.

Specifically, for the treatments with only floating voters, denoted by superscript *F*, the panel model is given by[20]

$$D_{i,t}^{F} = \beta_0^F + \beta_1^F \frac{t}{100} + \beta_2^F D_{i,t-1} + \beta_3^F \Delta LS_{i,t}^{<} + \beta_4^F \Delta LS_{i,t}^{>} + \beta_5^F PIV_{i,t-1}^{0} + \beta_6^F PIV_{i,t-1}^{1} + \varepsilon_{i,t} + \mu_i \quad (1)$$

and for the treatments with a mix of allied and floating voters, denoted by superscript *M*, by

$$\begin{aligned} D_{i,t}^{M} = \beta_0^M + \beta_1^M \frac{t}{100} + \beta_2^M D_{i,t-1}^{fl} + \beta_3^M D_{i,t-1}^{al} + \beta_4^M AL_i \\ + \beta_5^M \Delta LS_{i,t}^{<,fl} + \beta_6^M \Delta LS_{i,t}^{>,fl} + \beta_7^M \Delta LS_{i,t}^{<,al} + \beta_8^M \Delta LS_{i,t}^{>,al} \\ + \beta_9^M PIV_{i,t-1}^{0,fl} + \beta_{10}^M PIV_{i,t-1}^{1,fl} + \beta_{11}^M PIV_{i,t-1}^{0,al} + \beta_{12}^M PIV_{i,t-1}^{1,al} + \varepsilon_{i,t} + \mu_i , \end{aligned} \quad (2)$$

where *i* denotes the voter, and *t* denotes the round. $D_{i,t}^{F}$ ($D_{i,t}^{M}$) is a dummy variable equal to 1 if *i* voted in *t*, and 0 otherwise. *AL* in (2) is a dummy variable equal to 1 if *i* is an allied voter, and 0 otherwise. Moreover, superscripts *fl* and *al* indicate whether the independent variable concerns a floating or allied voter (we omit superscripts *fl* in (1) where there are only floating voters). $\Delta LS_{i,t}^{<}$ and $\Delta LS_{i,t}^{>}$ measure (absolute) differences in the levels of support between the two parties, where superscripts '<' ('>') indicate that *i* is in the minority (majority).[21] $PIV_{i,t-1}^{0}$ is a dummy variable equal to 1 if, in the previous round, *i* abstained (denoted by superscript '0') and was pivotal *ex post,* and 0 otherwise. Similarly, $PIV_{i,t-1}^{1}$ is a dummy variable equal to 1 if, in the previous round, *i* voted (denoted by superscript '1') and was pivotal, and 0 otherwise. $\varepsilon_{i,t}$ and μ_i are error terms, where the latter is a random effect used to correct for the panel structure in our data. Table 2 presents the maximum likelihood estimates of the coefficients of this model.

Table 2 can be used to distinguish between various effects of poll releases on voter turnout. First consider electorates with only floating voters. As already shown in figure 3, turnout increases in the level of disagreement (measured by $-\Delta LS_{i,t}^{<,fl}$ and $-\Delta LS_{i,t}^{>,fl}$) in IF. The coefficients −0.20 and −0.13 are both negative and highly significant, and indicate that

[20] To be more precise, eqs. (1) and (2) specify the linear (random) utility model underlying the probit estimations.

[21] $\Delta LS_{i,t}^{<}$ and $\Delta LS_{i,t}^{>}$ are inversely related to the level of disagreement as measured by the size of the minority (*SoM*). Specifically, $SoM = 6 - (\Delta LS_{i,t}^{<})/2 = 6 - (\Delta LS_{i,t}^{>})/2$.

the minority responds more strongly to differences in support than the majority. As a consequence, the relationship between the level of support and the probability of voting is inversely U-shaped.[22] As expected, the levels of disagreement do not affect turnout in UF. Interestingly, poll releases suppress other influences on voter turnout: previous turnout ($D_{i,t-1}^{fl} = 1$) and being previously pivotal ($PIV_{i,t-1}^{0,fl} = 1$ or $PIV_{i,t-1}^{1,fl} = 1$) increase the vote probability in UF, but no such effects are observed in IF. It seems like subjects use information from previous elections to determine their choice if there is no current information available. Very similar results hold when there are allied voters in the electorate (cf. section 5.2 for a comparison between both voter types). The main difference is that now being pivotal previously significantly increases turnout of informed voters in three out of four cases. Finally, we find a downward trend across rounds in all treatments except IM.

TABLE 2: RANDOM EFFECTS PROBIT ESTIMATIONS OF VOTER TURNOUT

Constant and independent variables	**Coefficients**			
	UF	**IF**	**UM**	**IM**
Constant	**-0.93** (16.18)***	**0.07** (1.00)	**-1.03** (14.77)***	**0.29** (4.80)***
t / 100	**-0.40** (6.23)***	**-0.20** (3.44)***	**-0.18** (2.76)***	**-0.05** (0.82)
$D_{i,t-1}^{fl}$	**0.48** (9.20)***	**0.00** (0.04)	**0.87** (11.47)***	**-0.02** (0.30)
$D_{i,t-1}^{al}$	-	-	**0.39** (5.27)***	**-0.00** (0.03)
AL_i	-	-	**0.70** (7.14)***	**-0.23** (3.00)***
$\Delta LS_{i,t}^{<,fl}$	**0.00** (0.32)	**-0.20** (13.78)***	**-0.02** (0.82)	**-0.26** (9.63)***
$\Delta LS_{i,t}^{>,fl}$	**-0.00** (0.07)	**-0.13** (11.45)***	**0.01** (0.52)	**-0.19** (12.56)***
$\Delta LS_{i,t}^{<,al}$	-	-	**0.02** (0.88)	**-0.24** (13.26)***
$\Delta LS_{i,t}^{>,al}$	-	-	**0.02** (1.17)	**-0.14** (8.17)***
$PIV_{i,t-1}^{0,fl}$	**0.27** (5.87)***	**0.01** (0.20)	**0.14** (2.10)**	**0.17** (2.35)**
$PIV_{i,t-1}^{1,fl}$	**0.19** (3.20)***	**0.00** (0.06)	**0.15** (1.76)*	**0.17** (2.41)**
$PIV_{i,t-1}^{0,al}$	-	-	**0.12** (1.71)*	**-0.04** (0.57)
$PIV_{i,t-1}^{1,al}$	-	-	**0.37** (4.89)***	**0.15** (2.16)**

Notes: The dependent variable is the voters' binary choice between voting (= 1) and abstaining (= 0). The independent variables in column 1 are defined in the main text. Absolute *z*-values are given in parentheses. * (**; ***) indicates significance at the 10% (5%; 1%) level. Results on the random effects estimates are available on request.

The following result summarizes our findings.[23]

ER2: *Polls cause turnout to increase in the level of disagreement, but stronger so for the minority than for the majority. Turnout probabilities always remain higher in the*

[22] Recall from figure 3, however, that even voters in a minority of 3 turn out at a lower rate than voters in the opposing majority of 9.

[23] ER2 is also supported by nonparametric tests using electorates as the unit of observation. More details are available from the authors.

majority than in the corresponding minority. Without polls, both being pivotal and having voted in the previous election increases turnout.

We can compare this result to TR2 and TR3 and the equilibrium turnout probabilities shown in figure 3. The inverse U-shape in the relationship between the level of support and turnout for informed treatments supports the logit predictions, but rejects the (Bayesian) Nash predictions (cf. TR2). However, our finding that turnout rates are not higher in the minority than in the opposing majority rejects both equilibrium predictions. A similar result is reported in Großer and Giertz (2006) and Klor and Winter (2007) with certainty about voting costs, but Levine and Palfrey's (2007) experiment supports the predicted higher turnout for the minority. The latter experiment includes uncertainty about voting costs.[24] Concerning the levels of disagreement, ER2 supports the logit predictions that turnout increases in this level and that polls increases (decrease) turnout for higher (lower) levels, but rejects the (Bayesian) Nash predictions (cf. TR3).

To conclude, this subsection has shown that poll releases have strong effects on voter turnout. Polls often redirect the voters' attention away from past events towards the current level of disagreement. This information yields important regularities in observed voter turnout; most strikingly, turnout increases in the level of disagreement (i.e., closeness matters).

5.2 TURNOUT RATES AND VOTER ALLIANCES

Aggregate turnout

Figure 2 not only shows an increase in aggregate turnout rates due to polls, but also that the presence of allied voters boosts participation. Turnout differences between all-floating electorates and electorates with allied voters start out relatively small, but they increase to an average of 24% and 17% in the last three blocks of rounds for the UM-UF and IM-IF comparisons, respectively. Only the latter difference is statistically significant, however.

ER3: *When there are polls, electorates with allied voters have higher turnout levels in later rounds.*

SUPPORT. Across all rounds, Wilcoxon-Mann-Whitney tests cannot reject the null hypothesis of no difference in turnout rates for the UM-UF and IM-IF comparisons at the 10%-level.

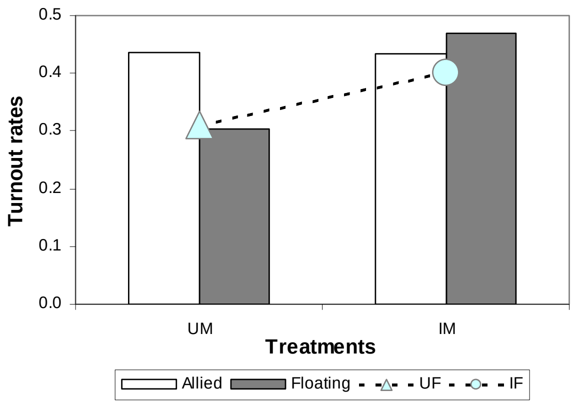
[24] Though this suggests that the cost setup may be important, we can think of another explanation for the discrepancy: Subjects in Levine and Palfrey's study faced the same level of disagreement in fifty consecutive rounds. This stable learning environment is not present in our environment (nor in the other two mentioned), where the level frequently changes.

Considering blocks 3-5 only, rates are significantly higher in IM than in IF (5% level) but the difference UM-UF is not significant.

Turnout per voter type

Figure 4 gives observed turnout rates per voter type. It shows that polls increase floating voters' participation by 55% but leave turnout by allied voters unaffected. One way to summarize the data underlying figure 4 is that turnout is around 40% for allied voters (independent of polls) as well as for informed floating voters (irrespective of the presence of allied voters). Only uninformed floating voters vote at a lower rate of approximately 30% (once again, irrespective of whether or not there are allied voters).

FIGURE 4: TURNOUT RATES FOR ALLIED AND FLOATING VOTERS



ER4: *The increase in turnout levels through polls is entirely due to floating voters.*

SUPPORT. A Wilcoxon-Mann-Whitney test cannot reject the null hypothesis of no difference in turnout rates between allied voters in the IM-UM comparison, but rejects it between floating voters in favor of higher rates in IM than UM at the 5% level. Recall from ER1 that when there are no allied voters, floating voters turnout significantly more in IF than in UF.

It is interesting that turnout rates of floating voters are not affected by the presence of allied voters (as expected from the figure, the relevant differences are statistically insignificant). However, the random effects probit estimations reported in table 2 do reveal some differences. For example, floating voters respond to *ex post* pivotalness in the previous round when there are allied voters (coefficients 0.17 for both $PIV_{i,t-1}^{0,fl}$ and $PIV_{i,t-1}^{1,fl}$) but not so if there are only floating voters (0.01 and 0.00, respectively).

Directly comparing the two voter types, we find larger differences in turnout rates when polls are prohibited (*cf.* figure 4): allied voters turn out 44% more than floating voters in UM and 8% less in IM. Though these differences are not statistically significant at the electorate level (Wilcoxon signed ranks tests, 10% level) the results in table 2 show that after correcting for other factors the individual uninformed allied voter is significantly more likely to vote than an uninformed floating voter; whereas an informed allied voter is significantly less likely to vote than an informed floating voter (the respective coefficients in table 2 for *AL* are 0.70 in UM and –0.23 in IM). Note, however, that allied and floating voters respond in very similar ways to the information about the level of disagreement that is revealed by polls (compare the coefficient for $-\Delta LS_{i,t}^{<,fl}$ to $-\Delta LS_{i,t}^{<,al}$ as well as $-\Delta LS_{i,t}^{>,fl}$ to $-\Delta LS_{i,t}^{>,al}$ in the last column of table 2).

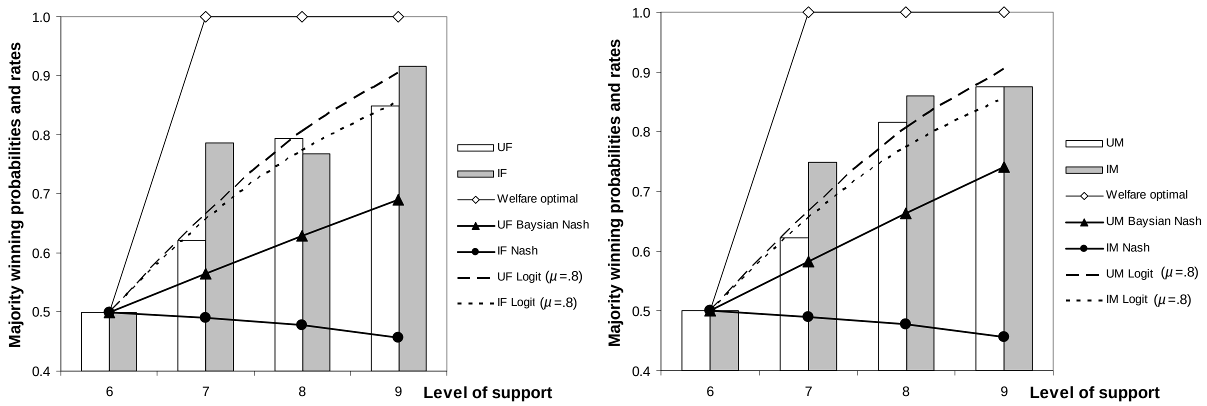
We can compare observed turnout rates in figure 4 to our equilibrium turnout probabilities in figure 1. In UM, the differences between higher rates of allied voters and lower rates of floating voters are much smaller than in the Bayesian Nash prediction. Moreover, turnout of allied voters is not large enough to boost the rates in UM above those in the other three treatments, which is predicted by the (Bayesian) Nash equilibria. On the other hand, differences in observed turnout rates across voter types and treatments are closer to –but still substantially above– the (near zero) differences predicted by the logit equilibria for $\mu \geq 0.3$.

5.3 WINNING PROBABILITIES

Both equilibrium concepts predict that turnout probabilities will be higher in the minority than in the opposing majority after polls have been released. In the Nash equilibrium (but not the logit equilibrium for $\mu \geq 0.3$), this difference is large enough to give the minority a higher probability of winning the election. However, observed turnout rates are not higher in the minority (cf. figure 3), which means that the majority wins more often. Figure 5 compares observed majority winning rates with and without polls.

FIGURE 5: WINNING RATES

ONLY FLOATING ALLIED AND FLOATING



Notes: Bars show the observed frequency of majority wins for the level of support shown. Lines show theoretical predictions based on Nash equilibrium, logit equilibrium and social welfare maximization. For presentational reasons, the logit predictions for μ = 0.4 are not shown. These lie between the Bayesian Nash predictions and logit predictions for μ = 0.8.

It also shows the theoretical predictions including the social welfare maximizing winning probabilities.[25] We add the (6,6) case for comparison, defining the winning rate of the 'majority' as 50%.

The figure shows that majorities win more than 50% of the time and (with one exception) the chance that they win is increasing in the level of support. For the uninformed treatments, this is a direct consequence of equal average turnout rates across the levels of support (since subjects cannot respond to what they don't know). Moreover, only for the support levels of 7 do the winning rates depend significantly on whether or not polls are released (cf. both panels in figure 5). When informed, a majority of 7 voters has a significantly higher chance of winning than when there are no polls (Wilcoxon-Mann-Whitney tests, 5% significance level for only floating voters and 10% level when mixed). These observations give:

ER5: *Majorities have a higher probability of winning the elections than the opposing minorities*.

SUPPORT. This follows from the discussion above.

Comparing this result to TR4 (and to the theoretical predictions depicted in figure 5 we observe that the logit equilibrium predicts the comparative statics much better than the (Bayesian) Nash equilibrium.

5.4 WELFARE EFFECTS

We consider the effects polls have on welfare at both the level of support ('group welfare') and level of disagreement ('social welfare'). Using equilibrium turnout probabilities to

[25] In case of unequal levels of support, social welfare is maximized if one majority-voter turns out and everybody else abstains. When support levels are equal social welfare is maximized if everybody abstains.

calculate expected payoffs in equilibrium we can determine expected group and social welfare.[26] From these, equilibrium welfare effects are calculated as the welfare with poll releases minus the welfare without such information and compared to our data.

Group welfare effects

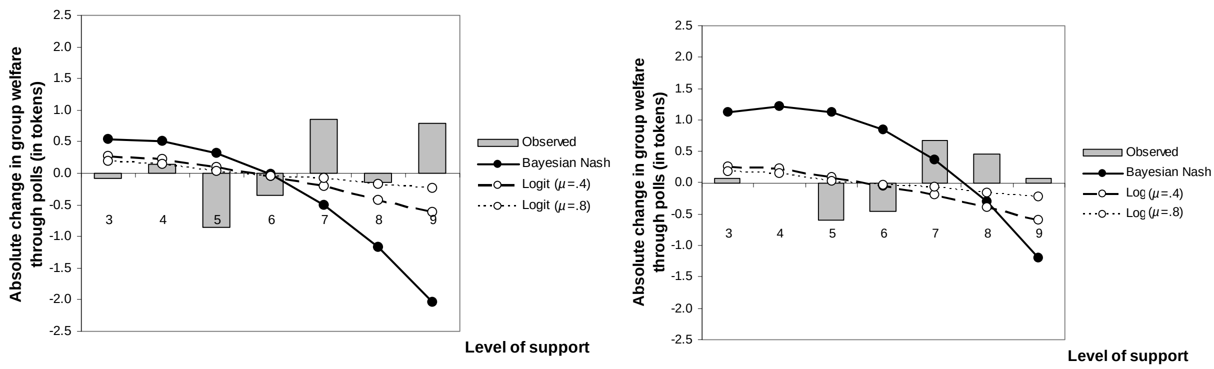
Figure 6 show the observed and predicted group welfare effects across levels of support. It reveals a stark contrast between our predictions and our observations. Whereas equilibria generally predict that polls benefit the minority and harm the majority (i.e.*,* the lines start above zero and decline to a negative prediction for the largest support level), we observe that the majorities are the groups whose welfare is more often boosted by the release of polls. Whereas 5 of the 6 majorities shown in figure 6 are better off with polls, this holds for only 2 of the 6 minorities.

Social welfare effects

Table 3 shows the effects polls have on social welfare, distinguishing between the cases with only floating voters (columns 2 to 6) and with allied and floating voters (columns 7 to 11). Rows present the Bayesian Nash predictions, logit predictions for $\mu = 0.4$ and 0.8, and data. One again, we find stark differences between the theoretical predictions and our observations

FIGURE 6: EFFECTS OF POLLS ON GROUP WELFARE

ONLY FLOATING VOTERS | ALLIED AND FLOATING VOTERS



Notes: The figure shows the effects of polls on group welfare, separately for only floating voters (left panel) and for allied and floating voters (right panel). Effects are measured as group welfare with polls – group welfare without polls. Bars show observed values of this difference across support levels and lines show theoretically predicted effects (Bayesian Nash predictions and logit predictions for μ equal to 0.4 and 0.8).

TABLE 3: EFFECTS OF POLLS ON SOCIAL WELFARE

[26] In the online appendix we relate predicted and observed welfare to maximum surplus and determine the efficiency of elections.

	Only floating voters					Allied and floating voters				
Level of disagreement	3	4	5	6	Weighted average	3	4	5	6	Weighted average
Bayesian Nash	-1.49	-0.66	-0.19	-0.02	-0.26	-0.07	0.92	1.50	0.84	1.14
logit $\mu = .4$	-0.35	-0.19	-0.12	-0.05	-0.12	-0.33	-0.18	-0.11	-0.05	-0.11
logit $\mu = .8$	-0.05	-0.03	-0.05	-0.05	-0.05	-0.05	-0.03	-0.05	-0.05	-0.04
Observed	0.72	0.00	0.01	-0.36	-0.08	0.14	0.45	0.07	-0.45	-0.02

Notes: Entries in the cell represent the predicted or observed effects of poll releases on social welfare for the situation depicted by the column. The average effect is weighted by the relative frequency with which the level of disagreement occurs in our experiment.

The theoretical predicted social welfare effect of polls is generally negative and often monotonically increasing in the level of disagreement (i.e., polls are predicted to harm social welfare and mostly so in lopsided elections; exceptions are found for the Bayesian Nash equilibrium with allied voters). The logit equilibrium smoothes out social welfare effects, yielding close to zero values for $\mu = 0.8$. Our data, on the other hand, only show a negative social welfare effect of polls for the highest disagreement level. Because this observed negative welfare effect weighs relatively highly in the weighted average this results in a small negative average welfare effect of −0.08 when there are only floating voters and −0.02 when there are allied and floating voters.

We summarize our findings in the following result:

ER6: *Polls mostly increase majority welfare and decrease or barely affect minority welfare. Without allied voters, social welfare decreases when the level of disagreement is highest.*

SUPPORT. Wilcoxon-Mann-Whitney tests reject the null hypothesis of no difference between group payoffs with and without polls in favor of lower payoffs with polls for minorities of 5 for both the IF-UF and IM-UM comparisons (1% and 10% significance level) and for support level 6 in the IF-UF comparison (10% level). Equal group payoffs are rejected in favor of higher payoffs with polls for majorities of 7 (5% level for IF-UF; 10% level for IM-UM) and for majorities of 8 for IM-UM (5% level). For all other minorities and majorities the null hypothesis cannot be rejected (10% level). Moreover, Wilcoxon-Mann-Whitney tests reject the null hypothesis of no difference between aggregate electorate payoffs with and without polls in favor of lower payoffs with polls for a level of disagreement of 6 for IF-UF (10% significance level), but for no other comparison at the disagreement level (10% level).

The logit equilibrium predicts the observed effects of polls on group and social welfare relatively better than the Bayesian Nash equilibrium (cf. TR5). However, the logit equilibrium cannot capture our ER6 either. Though the opposite is predicted by all our equilibria, our data suggest that the majority-preferred candidate should favor poll releases and the minority-preferred candidate should oppose them.

6. CONCLUSIONS

The aim of our study is to shed light on the effects of public opinion polls in two-candidate majoritarian elections. To do so, we use a novel setup where we theoretically and experimentally analyze and compare participation games where polls inform the electorate about the level of support for each candidate to those where voters remain uninformed. We believe one of the advantages of this method to be that political engineers can adapt it to study their own particular interests. Nevertheless, the environment we chose has allowed us to draw a variety of conclusions about the influence of poll releases on turnout and welfare.

Our Bayesian Nash analysis as well as the complementary theoretical work by Goeree and Großer (2007) and Taylor and Yildirim (2006) suggest that polls may have negative effects on social welfare. The main reason is that voters who (unexpectedly) learn that they are in a minority may be stimulated to participate substantially more than they had originally planned to do. This can diminish expected benefits from the election and decrease social welfare. This effect is most pronounced in electorates with low levels of disagreement (i.e., lopsided elections) where the incentive to free ride on costly votes of co-supporters is particularly weak in minorities and strong in majorities.

Our experimental results show that, overall, turnout is higher after polls have been released. Not all elections are equally affected by polls, however. The difference in turnout between electorates with and without polls is most striking for ex ante close races (where the level of disagreement is highest). For such elections, polls do yield severe welfare losses because turnout is much higher than is socially optimal. When elections are less close, the welfare consequences depend on the group a voter belongs to. We observe that polls mostly increase majority welfare and decrease or barely affect minority welfare. This can be attributed mainly to our observation that, contrary to the Nash predictions, informed majorities achieve a victory more often than the opposing minorities.

When distinguishing between allied and floating voters we observe that the higher turnout in informed electorates is caused by floating voters, who vote much less when there are no polls. Note that this cannot be attributed to them having lower stakes in the election outcome than allied voters (as is often assumed about floating voters). Our laboratory control allowed us to distinguish allied from floating voters on one dimension, to wit the instability in their preferences across elections. This instability causes uncertainty about the electorate's level of disagreement. We kept the stakes across voter types constant. Our experimental results show that the uncertainty *per se* is enough to reduce turnout by floating voters, with the consequences for aggregate turnout and welfare discussed above.

Generally, (Bayesian) Nash equilibrium poorly predicts experimental results for participation games while logit equilibrium provides substantially more accurate predictions (Cason and Mui 2005; Goeree and Holt 2005). Our results fit well into this general picture: our data do not support (Bayesian) Nash predictions but to a large extent coincide with those derived from logit equilibrium. In particular, most turnout levels and the patterns of turnout across levels of support and disagreement are explained very well by the latter equilibrium concept. Moreover, it mitigates the strong effects of polls on welfare predicted by Bayesian Nash, bringing our theoretical predictions much closer to the data. However, two of our experimental results remain at odds with logit equilibrium as well: (i) that majority voters turn out at a higher probability than the opposing minority voters in informed electorates (and, related to this, that polls generally increase majority but not minority welfare); (ii) that turnout is 50% or higher when support is equally divided across both candidates. There are various possible reasons why logit equilibrium fails here. We favor an explanation based on 'group think' (Bacharach 2006) where some voters determine their turnout decision based on group utilitarian rather than individualistic motives. In this setting, group welfare as opposed to individual well-being determines the voter's decision. Using this as a point of departure for informed electorates, one can once again calculate Nash equilibrium voting probabilities (Feddersen and Sandroni 2006). It turns out that Nash equilibria calculated in this way already predict quite well the comparative statics that we observe across support levels.[27] In particular, they correctly predict the higher turnout probabilities in the majority and an average turnout of 50% for the highest level of disagreement. A further improvement of the fit between predictions and observations may be obtained by combining the group think and logit models. To study this, however, an alternative experimental design would be much more suitable and we therefore leave this for future research.

Of course, our study of the effect of public opinion poll releases on turnout and welfare is to some extent limited. For example, we ignored the possibility that the information in polls may be biased by respondents who act strategically, and hence polls may be less representative than in our study. Moreover, we have focused on majority rule. Results may

[27] More details are available from the authors.

be different for proportional representation (as pointed out by Irwin and van Holsteyn 2000). Future research should relax some of the assumptions in our setup (e.g., using larger electorates with a larger variety of disagreement levels, asymmetric distributions of support levels, endogenous poll responses, and different electoral rules). By relaxing these and other limitations, we are confident that our setup can be extended to other situations and thus contribute to a more general understanding of the effect of poll releases on turnout and welfare. Our present theoretical and experimental results are a first important step in this direction.

APPENDIX

See our online appendix on _______ (add website)

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