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 (and relatively low welfare) is observed when polls indicate equal support levels for the candidates. Though in aggregate social welfare hardly changes, majorities generally benefit from polls whereas minorities are unaffected or lose. Finally, many of our results are well predicted by quantal response (logit) 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 (Palfrey and Rosenthal 1983; Ledyard 1984). For example, higher turnout decreases welfare because it increases aggregate voting costs. 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 majority-preferred candidate wins.[4] For

[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 are 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

example, if higher turnout (e.g., induced by a poll release) increases this 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 the voters' preferences, turnout positively affects the majority's chances (thus, the electorate's aggregate benefits). 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. 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.[5] Our model and controlled laboratory experiment 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.[6] In the rational turnout model of Downs (1957), for example, a voter will vote if the expected benefits exceed the voting costs. Because the expected benefits change if the perception of the level of disagreement (i.e., the pivot probability) changes, polls may affect turnout in these models (e.g., Brown and Zech 1973; Zech 1975; and Gärtner 1976). Indeed, many field studies have supported the notion that turnout increases in fierce races. These are generally based on the *ex post* closeness of elections, i.e., the closeness based on actual votes cast (for a valuable survey see Matsusaka and Palda 1993). In contrast, our experiment allows us to examine this notion by controlling for the true *ex ante* level of disagreement in the electorate, i.e., closeness based on

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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'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. For the relationship between turnout and welfare in very small electorates see 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).

[6] Of course, polls typically contain more information than just the levels of support for the various candidates. For example, they are also barometers of public opinion about specific politicians' leadership qualities and the sympathy they receive from the electorate. However, the levels of candidates' support and the expected closeness of upcoming elections is undoubtedly crucial information heavily discussed in the media.

the electorate's preferences. Note that the ex ante level of disagreement is difficult to estimate in the field, whereas it is precisely known in the laboratory.

The uncertainty about the electorate's level of disagreement is often substantial. To a large extent, this is caused by *floating* voters, who decide on their support on a case-by-case basis.[7] Hence, floating voters are a main reason why pollsters 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). In contrast to floating voters, *allied* voters are characterized by stable preferences across legislative periods. The distinction between allied and floating voters is important because they may respond differently to information in polls (e.g., the long-term attachment of allied voters to their group may override this short-term, election-specific information). Moreover, the interaction between these two types of voters may influence their behavior. It is thus important to study the effect of poll releases for electorates where allied and floating voters coexist. Our model and laboratory experiment allow us to empirically investigate in a systematic way the effects of poll releases on turnout in aggregate and for each voter type separately. We will do so by using electorates with only floating voters and with both allied and floating voters.

Previous studies on public opinion polls and voter behavior (e.g., Simon 1954; for a valuable survey see Irwin and van Holsteyn 2000) have 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, our interest lies in the effect of polls on the *turnout decision* where candidate choices are fixed. 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

[7] 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).

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 releases on voter turnout and welfare, however.[8]

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.

On the other hand, the relevance of our results for elections outside of the laboratory depends on the external validity of our experiment. To some extent, this depends on the theoretical model underlying our study. Levine and Palfrey (2007) provide arguments that the external validity of the participation game is high in this respect. The validity of our experiment finds further support if our data reproduce important empirical regularities observed in the field, such as the higher turnout in closer elections (cf. Matsusaka and Palda 1993). This is indeed the case. For a further discussion of the external validity of laboratory experiments, see Schram (2005).

The remainder of this paper is organized as follows. The following section describes the participation games that are the backbone of our experiments. This is followed by our experimental design in section 3. Section 4 presents our equilibrium predictions. The experimental results are described and analyzed in section 5. Section 6 concludes.

[8] 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).

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).[9] 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.[10]

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 she or he voted. Supporters of the defeated candidate receive smaller rewards. Assuming that the stakes are equal in both groups, 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.[11] The equilibrium turnout probabilities of these games can be derived and used to compute the winning probabilities of the two candidates and expected welfare (cf. the online appendix). Specific predictions for our experimental parameters are given in the following sections.

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

(*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

[9] 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.

[10] See http://www.feb.uva.nl/creed/pdffiles/pollsappendix.pdf or http://website.fsu.edu/jgrosser/research.htm.

[11] 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 through polls of uncertainty about the level of disagreement, we avoid confronting subjects in the laboratory with additional sources of uncertainty and use constant costs and benefits across voters. It should be noted, however, that one interpretation of the noise parameter in the quantal response equilibrium we will discuss below is that it captures individual idiosyncrasies such as uncertainty about costs.

(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 their 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 pollsters publish information.

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 and varying costs (Cason and Mui 2003; 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 study with cost uncertainty (Levine and Palfrey 2007) the standard (Bayesian) Nash equilibrium concept finds little empirical support in the experimental literature on participation games. 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. For example, contrary to Bayesian Nash, quantal response equilibrium can predict substantial turnout (in the order of 50%) in large elections (Levine and Palfrey 2007). Therefore, our theoretical predictions presented in sections 4 and 5 will focus on this equilibrium concept. [12]

[12] The online appendix describes the Bayesian Nash equilibria for our game. These equilibria are indeed poor predictors of behavior observed in our experiments.

3. EXPERIMENTAL DESIGN

PROCEDURES AND TREATMENTS

The computerized[13] experiment was run at the CREED laboratory at the University of Amsterdam. 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 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.

UNCERTAINTY ABOUT THE LEVEL OF DISAGREEMENT

Information and voter alliance were both varied between subjects. To create 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 level of disagreement by the size of the minority. Note that this level indeed increases with this size.

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

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.[14] 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 depended 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.[15] Hence, subjects in 'uninformed' faced the same decision problem in each round.[16]

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.

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

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

[16] 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.

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

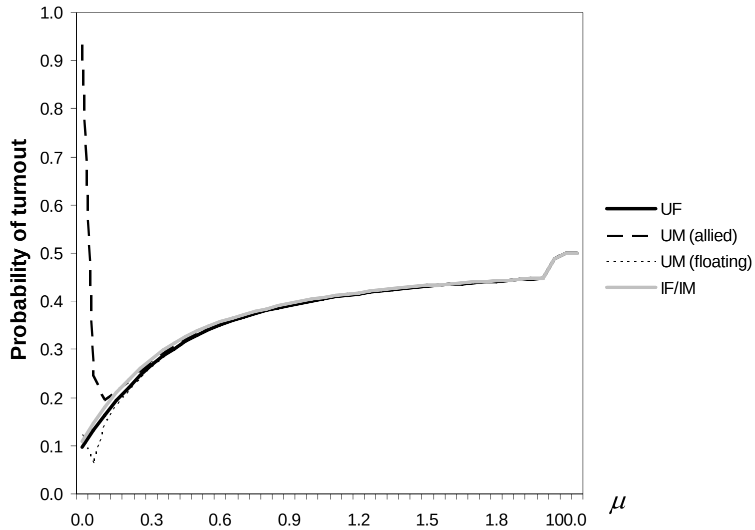
For the parameters of our experiment, we can numerically derive (Bayesian) Nash equilibria and quantal response equilibria (McKelvey and Palfrey 1995). The latter are characterized by a non-negative 'noise' parameter μ. The (Bayesian) Nash equilibrium is a limit case of the quantal response equilibrium 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 (a.k.a. the 'logit equilibrium'; see McKelvey and Palfrey 1995). As is common in the participation game literature we focus on quasi-symmetric equilibria, i.e. voters who face the same decision problem vote with same probability.[17]

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 experiment. Because in these treatments pre-election information is exactly the same for allied and floating voters, we show one aggregate turnout probability. For the uninformed treatments (UF and UM) slight differences in the expected levels of disagreement may occur between both voter types (cf. footnote 16). Hence, we show separate turnout probabilities for allied and floating voters.

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

[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. We have also derived pure strategy (Bayesian) Nash equilibria. However, these do not yield testable predictions about our treatment effects and, hence, are only described in the online appendix.

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.

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 (recall that in the informed treatments these are aggregate probabilities; disaggregated turnout probabilities differ across the distinct levels of support). These logit equilibria are increasing in μ and 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.

In the following we focus on these logit equilibria for $\mu \geq 0.3$ to derive qualitative *theoretical results* (TR) relevant to our experiment. These equilibria specify turnout probabilities (disaggregated per level of support in informed treatments) and we use them to compute equilibrium predictions for winning probabilities and expected welfare. We do so in aggregate; per level of support; and per level of disagreement. Moreover, 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 evaluate the comparative statics predicted by logit equilibrium. In presenting our TR we do not distinguish between voter alliance treatments, because they provide the same qualitative predictions.

THEORETICAL RESULTS FOR OUR LOGIT EQUILIBRIA ($\mu \geq 0.3$):

TR1 (aggregate turnout): *Polls do not affect aggregate expected turnout.*

TR2 (turnout per level of support): *Polls increase turnout probabilities for intermediate levels of support and decreases it for relatively small or large levels.*

ARGUMENT. The online appendix shows that turnout probabilities are highest for intermediate support levels. TR2 follows because all uninformed voters have a (same) predicted turnout in between the levels predicted for various (known) support levels. Hence, disclosure of the support levels in polls will increase (decrease) turnout if these levels are (not) at an intermediate level.

TR3 (turnout per level of disagreement): *Polls increase expected turnout for high levels of disagreement and decrease it for low levels.*

ARGUMENT. This follows directly from TR2 because high levels of disagreement imply intermediate levels of support.

TR4 (winning probabilities): *Polls somewhat diminish the advantage of the majority-preferred candidate for all levels of disagreement.*

ARGUMENT. The majority-preferred candidate always has better chances in the election than the minority opponent. The probability of winning strongly increases in the level of support in uninformed electorates. It also increases, but to a somewhat lesser extent, in the level of support in informed electorates.

TR5 (welfare): *Polls have little effect on expected social welfare, but minority welfare slightly increases and majority welfare slightly decreases after polls are released.*

ARGUMENT. This is a direct consequence of TR2 and TR4: for example, if polls reveal a low level of disagreement, turnout in both the minority and majority is suppressed (which increases social welfare). The relative probability of the minority winning increases, however, which decreases social welfare. The net effect is small but the welfare of the minority (majority) increases (decreases). The reverse effects hold if polls reveal a high level of disagreement.

5. EXPERIMENTAL RESULTS

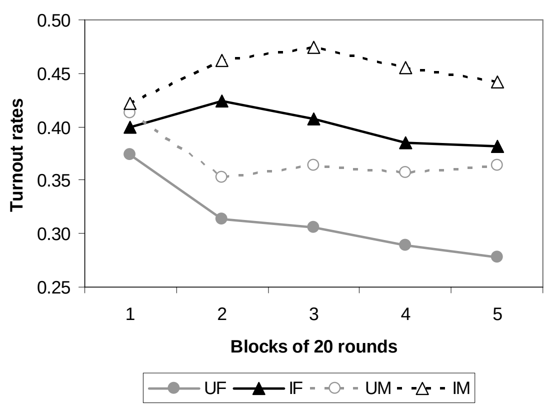
The presentation and analysis of our experimental results is organized as follows. We start by discussing observed effects of polls on turnout rates in aggregate and per level of support and disagreement (5.1). Thereafter, we investigate turnout rates per voter type (5.2). Then, we examine winning probabilities (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 sometimes provide the specific theoretical 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 (including the (Bayesian) Nash 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.

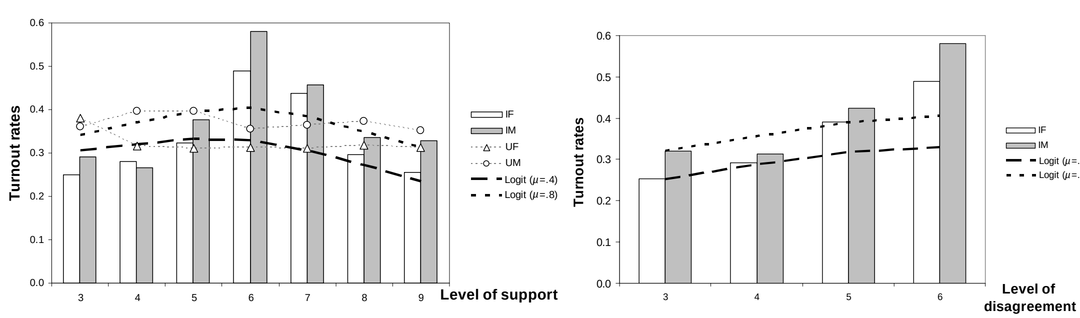
Note that ER1 rejects the comparative statics predicted by the logit equilibria (cf. TR1). However, the logit predictions using $\mu = 0.4$ ($\mu = 0.8$) lie for all treatments between 30% and 31% (38% and 39%) and are close to our observations. Hence, logit equilibrium can explain aggregate turnout reasonably well, but it fails to predict 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 logit predictions for noise levels μ = 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 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 levels of support and decrease turnout for small or large levels of support. 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 the quasi-symmetric equilibrium strategies, their turnout decisions should not be affected by past events. We distinguish between allied and floating voters in our mixed treatments. Specifically, for the treatments with only floating voters, denoted by superscript F, the panel model is given by[20]

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

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

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

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

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

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 only floating voters are considered). $\Delta LS_{i,t}^{<}$ and $\Delta LS_{i,t}^{>}$ measure (absolute) differences in the levels of support between the two groups, 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 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. 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

[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.

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.

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.

The following result summarizes our findings.[22]

ER2: *Polls cause turnout to increase in the level of disagreement, but stronger so for the minority than for the majority. Turnout probabilities are always higher in the 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 equilibrium predictions in TR2, but our finding that turnout rates are not higher in the minority than in the opposing majority rejects the quantitative predictions shown in figure 3. 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 probabilities for the

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

minority. The latter experiment includes uncertainty about voting costs.[23] Concerning the levels of disagreement, ER2 supports the predictions that turnout increases in this level and that polls increases (decrease) turnout for higher (lower) levels (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*.

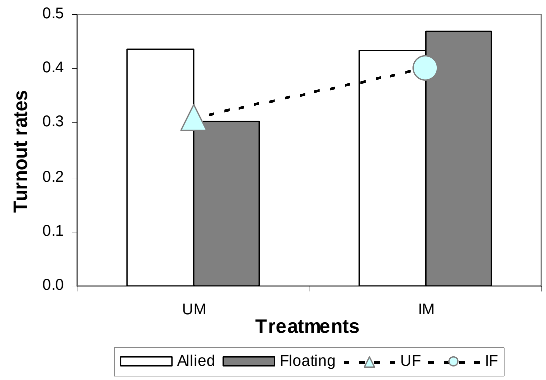
SUPPORT. Across all rounds, Wilcoxon-Mann-Whitney tests cannot reject the null hypothesis of no difference in turnout rates for the UM-UF and IM-IF comparisons at the 10%-level. Considering blocks 3-5 only, rates are significantly higher in IM than in IF (5% level) but the difference UM-UF is not significant.

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).

[23] 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), because our purpose is to study frequent changes in preferences across elections. Consequently, our experimental design does not provide a suitable environment to study learning towards equilibrium.

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 turn out 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).

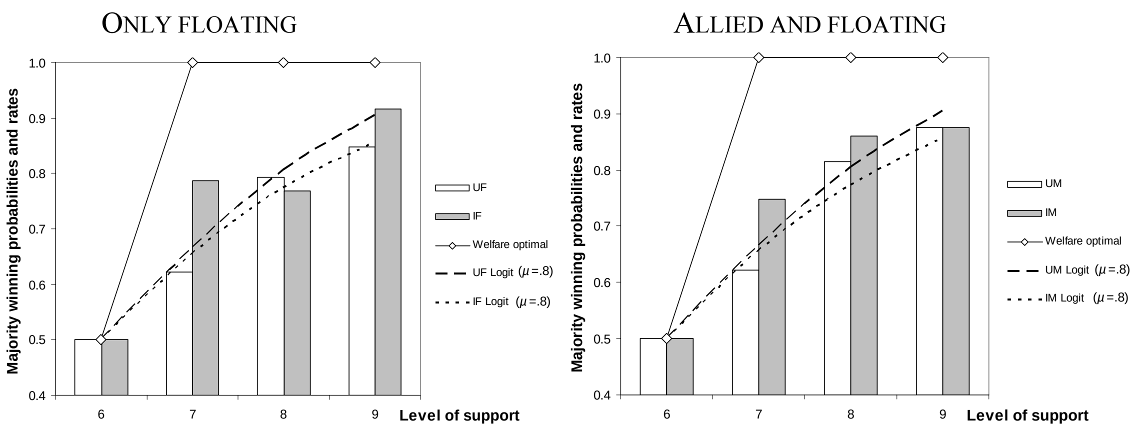
Directly comparing the two voter types, we find larger differences in turnout rates when polls are prohibited (cf. figure 4): allied voters turn out 44% more than floating voters in UM and 8% less in IM. Though these differences are not statistically significant at the electorate level (Wilcoxon signed 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).

Finally, we can compare observed turnout rates in figure 4 to our logit equilibrium turnout probabilities for $\mu \geq 0.3$ in figure 1. Differences in observed turnout rates across voter types and treatments are larger than the (near zero) differences predicted by logit equilibria (cf. TR1).

5.3 WINNING PROBABILITIES

Logit equilibrium for $\mu \geq 0.3$ predicts that turnout probabilities will be higher in the minority than in the opposing majority after polls have been released, but this difference is insufficient to give the minority a higher probability of winning the election. In contrast, observed turnout rates are not higher in the minority (cf. figure 3), from which it follows directly that the majority wins more often. Figure 5 compares observed majority winning rates with and without polls. It also gives theoretical predictions including the social welfare maximizing winning probabilities.[24] We add the (6,6) case for comparison, defining the winning rate of the 'majority' as 50%.

FIGURE 5: WINNING RATES



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

Figure 5 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

[24] 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.

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. Polls further increase this difference in close elections.*

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 well.

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 compute expected payoffs in equilibrium we can determine expected group and social welfare.[25] 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 shows 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

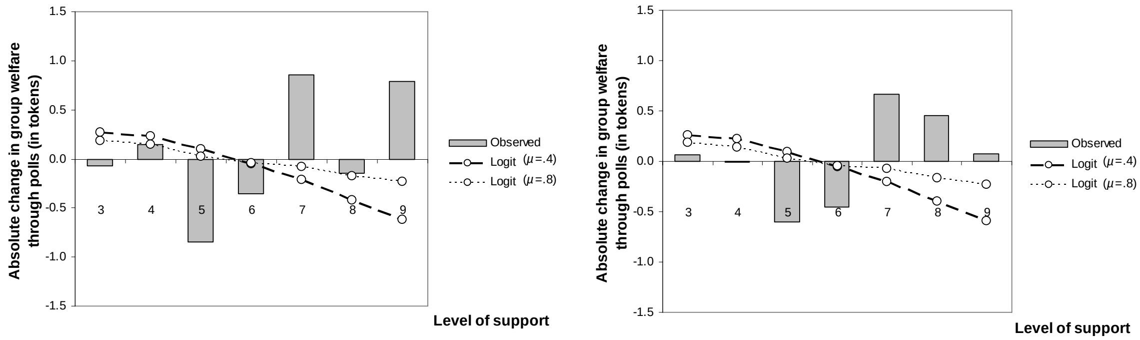
Table 3 shows the effects polls have on social welfare, distinguishing between the cases with only floating voters (columns 2 to 6) and with allied and floating voters (columns 7 to 11). Rows present the logit predictions for $\mu = 0.4$ and 0.8, and our data.

The theoretical predicted social welfare effect of polls is negative and (generally) monotonically increasing in the level of disagreement (i.e., polls are predicted to harm social

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

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 the logit predictions for μ equal to 0.4 and 0.8.

TABLE 3: EFFECTS OF POLLS ON SOCIAL WELFARE

	Only floating voters					**Allied and floating voters**				
Level of disagreement	3	4	5	6	Weighted average	3	4	5	6	Weighted average
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.

welfare and mostly so in lopsided elections; exceptions are found for the Bayesian Nash equilibrium with allied voters). 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, poll releases decrease social welfare 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 weighted overall social welfare well (cf. TR5). However, it does not capture the observed increase in majority welfare caused by polls. Though the opposite is predicted by logit equilibrium, 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 equilibrium 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. Such an 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 closest 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 polls indicate more distinct levels of support, 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 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. This cannot be attributed to them having lower stakes in the election outcome than allied voters (as is often assumed about floating voters), because we kept costs and benefits constant across voter types. 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. 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, logit equilibrium is a good predictor of our experimental results. In particular, most turnout levels and the patterns of turnout across levels of support and disagreement are explained very well. However, two of our experimental results remain at odds with logit equilibrium: (i) that majority voters turn out at a higher probability than the opposing minority voters in informed electorates (and as a consequence, that polls generally increase majority but not minority welfare); (ii) that turnout in informed electorates 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 rule-utilitarian rather than individualistic motives (Feddersen and Sandroni 2006). 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 derive (Nash) equilibrium voting probabilities (Coate and Conlin 2004). It turns out that these equilibria predict quite well the comparative statics that we observe across support levels and that they can partly explain what was left unexplained by logit equilibrium.[26] In particular, they correctly predict the higher turnout probabilities in the majority and an average turnout of 50% for the highest level of disagreement (causing higher aggregate turnout with than without poll releases). A further improvement of the fit between predictions and observations may be obtained by

[26] More details are available from the authors.

combining the logit and group think 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 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., by using larger electorates with a larger variety of disagreement levels or endogenous poll responses). By relaxing such assumptions, we are confident that our setup can 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. The striking similarity of our results with those observed outside of the laboratory (for example the high turnout in close elections) suggests that if laboratory and field studies proceed hand in hand, further insights of high practical value may be gained on the effects of polls on voter turnout and welfare.

APPENDIX

See our online appendix on http://www.feb.uva.nl/creed/pdffiles/pollsappendix.pdf or http://website.fsu.edu/jgrosser/research.htm.

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