Information Aggregation and Turnout in Proportional Representation: A Laboratory Experiment*

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Abstract

This paper documents a laboratory experiment that analyses voter participation in common interest proportional representation (PR) elections, comparing this with majority rule. Consistent with theoretical predictions, poorly informed voters in either system abstain from voting, thereby shifting weight to those who are better informed. A dilution problem makes mistakes especially costly under PR, so abstention is higher in PR in contrast with private interest environments, and welfare is lower. Deviations from Nash equilibrium predictions can be accommodated by a logit version of quantal response equilibrium (QRE), which allows for voter mistakes.

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1 Introduction

Voter participation is an essential component of democracy, and changes in the level of participation may affect electoral outcomes, the political positioning of the competing parties, and ultimately public policy. Because participation is the most readily observable decision that voters make, it provides a useful window into voter rationality and motivations, and so has been the subject of voluminous literature. Like other political behaviors, however, the decision of whether to vote or not likely depends in part on the electoral rule used to aggregate votes. Existing literature focuses almost exclusively on majority rule. An alternative electoral system that has grown increasingly prevalent in parliamentary elections, and is now used in over 53% of countries, is proportional representation (PR), which seeks to match legislative seats more proportionally to vote shares.[1]

It is inherently difficult to get reliable estimates of the causal impact of political institutions on political behavior such as voting because, as Acemoglu (2005) points out, institutions themselves are endogenous, and depend on a myriad of cultural and historical idiosyncrasies that are difficult to control for. Early cross-national comparisons of turnout under PR and majority rule find higher turnout under PR,[2] but often do so by excluding important cases, such as New Zealand, where turnout declined with the switch from majority rule.[3] In his survey on voter turnout, Blais (2006) concludes that many of these empirical findings are not robust, or lack compelling microfoundation. To avoid these challenges, we turn to the experimental laboratory.

Existing literature offers several experimental comparisons of turnout under PR and majority rule.[4] However, all of these implement *private interest* models of elections, meaning that voters have common information, but derive idiosyncratic utilities from various policy outcomes. This paper documents the first laboratory experiment (to our knowledge)

[1] See the webpage of the ACE Electoral Knowledge Network, http://aceproject.org/epic-en/CDTable?question=ES005&set_language=en (accessed 9/1/2015). PR elections are especially prevalent in Europe and Latin America.

[2] For example, see Powell (1980, 1986), Crewe (1981), Jackman (1987), Blais and Carthy (1990), Jackman and Miller (1995), and Franklin (1996).

[3] See Blais (2000, 2006). Switzerland is a prominent example of a PR system with low turnout. Evidence from Latin America also runs counter to folk wisdom, as well.

[4] See Schram and Sonnemans (1996), Herrera, Morelli and Palfrey (2014), and Kartal (2015b) for experimental comparisons of these two institutions. Other examples of papers studing participation under majority rule are Cason and Mui (2005), Levine and Palfrey (2007), Großer and Schram (2010) and Blais and Hortala-Vallve (2016a,b). See also Kamm and Schram (2014) for PR. For a compehensive survey of this literature, see Palfrey (2015) and Kamm and Schram (2016).

that instead implements a *common interest* specification, meaning that voters ultimately share a desire to implement whichever policies are truly best for society, but have imperfect information about which policies these are; in other words, elections serve to aggregate *information*, rather than preferences. This distinction is important for both empirical and theoretical reasons. It is important empirically because an extensive literature finds information to be the most important empirical determinant of voter participation: voter surveys show political knowledge, attention to politics and education to be the variables most closely associated with voter participation, while field experiments reveal the impact of information on turnout to be causal.[5] It is important theoretically because the private and common interest paradigms make opposite predictions regarding turnout. As long as support for two opposing sides is not precisely balanced, Herrera, Morelli, and Palfrey (2014) show that turnout in a private interest model should be higher under PR than under majority rule.[6] In a common interest setting, however, we find in Herrera, Llorente-Saguer, and McMurray (2018) that PR gives voters a stronger reason to abstain.

In a central paper on information aggregation in large elections, Feddersen and Pesendorfer (1996) explain the empirical importance of information by pointing out that voters who lack strong knowledge of the issues or candidates can use abstention as a way of strategically delegating their decision to those who know more, thereby avoiding the *swing voter's curse* of overturning an informed decision.[7] This information rationale for abstention is also useful for understanding why voters might skip races on a ballot, even after voting costs are sunk[8], and has been successfully reproduced in laboratory experiments.[9] In Herrera et al. (2018), however, we point out that because it relies on the pivotal

[5]For an extensive review of this empirical literature, see Blais (2000) and also McMurray (2015). Guiso et al. (2017) also find survey evidence that turnout is highly correlated with attention to political news.

[6]See also Faravelli and Sanchez-Pages (2014), Kartal (2015a), and Herrera, Morelli, and Nunnari (2015).

[7]The common interest assumption, which traces back to Condorcet (1785), is important because better-informed peers are only helpful if they share a voter's own preferences. For a detailed discussion of this assumption, see McMurray (2017a). The common interest approach to elections has supported a variety of applications, including Feddersen and Pesendorfer (1998), Martinelli (2006), Bouton and Castanheira (2012), Ahn and Oliveros (2016), Bouton et al. (2016), McMurray (2013, 2017b,c,d). For a review of early contributions, see Piketty (1999). These theoretical constributions have also inspired experimental research. See, for instance, Guarnascheli et al. (2000), Goeree and Yariv (2011), Bhattacharya et al. (2014), Fehrler and Hughes (2015), Le Quement and Marcin (2015), Mattozzi and Nakaguma (2015), Bouton et al. (2017), and Kawamura and Vlaseros (2017). See Palfrey (2015) for an overview.

[8]Empirically, Wattenberg, McAllister, and Salvanto (2000) find a lack of political knowledge to be the most significant factor explaining partial ballots.

[9]Battaglini, Morton and Palfrey (2008, 2010), Morton and Tyran (2011), and Mengel and Rivas (2016) document abstention for informational reasons under majority in the laboratory. Großer and Seebauer

voting calculus, the swing voter's curse only applies to majority rule, and cannot explain abstention in PR elections. That paper identifies a different rationale for abstention that applies to PR instead, namely that voters abstain to avoid the *marginal voter's curse* of diluting the pool of informed opinions. This new rationale is useful because, empirically, information seems just as important for turnout in PR as it is for majority rule.[10] Partial ballots seem just as prevalent under PR, as well.[11]

This paper develops a new model that is similar in spirit to Herrera et al. (2018), but better suited to laboratory experiments, since it includes only a finite number of voters and only two information levels. Because the model is not fully tractable, we combine the theoretical analysis with numerical simulations to study the properties of both electoral systems. We find that voters with high levels of information should vote more frequently than those with low levels of information. The tendency to vote should also be higher in electorates that are more partisan. For any level of partisanship, abstention should be weakly higher under PR than under majority rule. All of these comparative static results mimic those found in Herrera et al. (2018). The logic generating these results is that, under PR, one vote dilutes the impact of other votes. Mistakes therefore have more permanent impact, and so are more costly, and voters with low levels of information are more careful to avoid them. Abstention is lower in more partisan electorates because a voter is less willing to trust the decision of his peers, who are less likely to share his preferences.

After deriving the implications of the theoretical model, we test these predictions in a laboratory experiment with a 2×3 between-subjects design, varying both the voting rule and the preference composition of the electorate. Perhaps not surprisingly given the complexity of the experiment, levels of voting and abstention by laboratory participants do not closely match the point predictions of the equilibrium analysis. However, patterns of participation align closely with the equilibrium comparative static predictions of the model. In particular, abstention is higher under PR than under majority rule, and welfare

(2016) show that abstention also takes place in a setting with endogenous information.

[10] For example, see Sobbrio and Navarra (2010) and Riambau (2018).

[11] In the 2011 Peruvian national elections, for example, 12% of those who went to the polls failed to cast valid votes in the Presidential election (the first round of a runoff system), but larger fractions, namely 23% and 39% respectively, failed to vote in the PR elections for Congress and for the Andean Parliament. A lack of information seems just as plausible a rationale for abstention in these elections as in the presidential election.

is lower. For either electoral rule, abstention decreases with partisanship. Voters with better information are more likely to vote, and the best informed voters rarely abstain. Some informed voters do abstain, and some voters vote contrary to their private signals; such behavior is difficult to square with the equilibrium model, but fits readily into an augmented model, in which voters make mistakes computing the expected utility associated with various actions.

To our knowledge, this paper is the first to compare strategic abstention under PR and majority rule in a common interest, laboratory environment. As such, it relates closely to two strands within the experimental literature. One of these strands compares turnout across electoral rules in private interest settings. Schram and Sonnemans (1996) offer the first such experiment, showing that whenever the support for each of the two alternatives is balanced, turnout tends to be higher under majority rule. However, Herrera, Morelli and Palfrey (2014) and Kartal (2015b) then consider environments where one of two parties expects greater support than its rival, which is the generic condition, and show that turnout is instead higher under PR. Whereas these models focus on private interest and costly voting, ours focuses on common interest and costless voting, and makes the opposite prediction.[12]

A second strand of experimental literature studies strategic abstention. Battaglini, Morton and Palfrey (2008, 2010) first document laboratory responses to the swing voter's curse, confirming that informed voters participate more often than uninformed voters, and that many uninformed voters vote to correct for the presence of biased partisans. Those authors analyze a rather stark case in which voters are either perfectly informed or perfectly uninformed; Morton and Tyran (2011) study a related setting in which voters receive noisy but informative information with different precisions, finding that poorly informed voters tend to vote less than highly informed voters, even when this is harmful for collective welfare. However, all of these studies focus exclusively on majority rule; to the best of our knowledge our experiment is the first one to study strategic abstention under alternative rules (and PR in particular).

[12] For a compehensive survey on the private-interest experimental literature comparing turnout under majority rule and PR, see Kamm and Schram (2016). Comparing PR and majority rule, even beyond the specific issue of voter participation, is an active line of research outside experimental literature, as well; for example, see Persson and Tabellini (2003).

2 The Model

A group of n voters must choose a policy from the interval $[0,1]$, by voting for political parties A and B associated with policy positions 0 and 1 on the left and right extremes. At the beginning of the game, each voter is independently designated as a *non-active voter*, as a *partisan*, or as an *independent*, with respective probabilities $p_\varnothing$, p and $p_I = 1 - p_\varnothing - p$. *Non-active voters* cannot vote, and are completely passive.[13] Each *partisan* independently prefers A or B with equal probability, and her utility increases the closer the implemented policy is to their preferred party. Without loss of generality, we assume that the utility functions of A-partisans and B-partisans are $u_A(x) = 1 - x$ and $u_B(x) = x$ respectively. *Independents* have common values, and have uncertainty about which is the superior alternative. In particular, there are two possible states of the world, denoted by $\omega \in \{\alpha, \beta\}$. Each state materializes with equal probability, i.e., $\Pr(\alpha) = \Pr(\beta) = \frac{1}{2}$. Independent voters' preferences are such that

$$u(x|\omega) = \begin{cases} 1 - x & \text{if } \omega = \alpha \\ x & \text{if } \omega = \beta \end{cases} \tag{1}$$

Information Structure. The state of the world cannot be observed directly, but independent voters observe private binary signals $s_i \in \{s_\alpha, s_\beta\}$ that are informative of the state ω.[14] These signals are of heterogeneous quality, reflecting the fact that voters differ in their expertise on the issue at hand. Specifically, each independent voter is independently designated to have a high level of information with probability p_H and to have a low level of information with complementary probability p_L. Voters are privately informed about their types. Conditional on ω, signals are then drawn independently with

$$\begin{aligned} \Pr(s = s_\alpha|\omega = \alpha) &= \Pr(s = s_\beta|\omega = \beta) = q_i \\ \Pr(s = s_\alpha|\omega = \beta) &= \Pr(s = s_\beta|\omega = \alpha) = 1 - q_i \end{aligned}$$

[13] This form of population uncertainty follows Feddersen and Pesendorfer (1996). With a known number of voters, the swing voter's curse would depend heavily on whether that number is even or odd. If it is odd, for example, there is always an equilibrium with full participation, because a vote is then pivotal only if the rest of the electorate is evenly split. In that case, a citizen infers no information beyond his or her own signal, and therefore has a strict incentive to vote. Population uncertainty also eliminates equilibria in weakly dominated strategies, such as all citizens voting A.

[14] Partisans could receive signals as well, of course, but would ignore them in equilibrium.

for $q_i = \{q_H, q_L\}$, where $\frac{1}{2} < q_L < q_H < 1$.

Voting. Once types are realized, voters vote simultaneously. Voters can vote (at no cost) for party A or for party B, or may abstain. We denote these actions as a, b, and $\varnothing$ respectively.

Electoral Rules. We consider two different electoral rules. Under *Majority Rule (M)*, the policy implemented is the policy of the party with a larger amount of votes. That is, if v_A and v_B denote the numbers of votes cast for A and B, respectively, then $x = 0$ if $v_A > v_B$ and $x = 1$ if $v_A < v_B$, breaking a tie if necessary by a fair coin toss. Under *Proportional Representation (PR)*, the policy outcome is a weighted average of the parties' policy positions, with weights given by the parties' vote shares. That is, if a fraction $\lambda_A = \frac{v_A}{v_A+v_B}$ of the electorate votes for party A and a fraction $\lambda_B = \frac{v_B}{v_A+v_B}$ votes for B, then the policy outcome is given by $x(a,b) = 0\lambda_A + 1\lambda_B = \lambda_B$, which may be anywhere between 0 to 1.[15] In case of $v_A = v_B = 0$, the final policy is $x = \frac{1}{2}$.

Strategies and equilibrium concept. Partisans have a dominant strategy to vote for their preferred alternative. Therefore, in the subsequent analysis we focus on the strategies of the independent voters. Let $\Theta = \{q_L, q_H\} \times \{s_\alpha, s_\beta\}$ denote the set of possible independent types, with θ_s^i denoting the type information of type i who has received signal s, and $\sigma : \Theta \longrightarrow \Delta\{a, b, \varnothing\}$ a strategy profile. Let $\sigma_c(\theta)$ denote the probability that an independent voter of type θ plays action c. We focus on symmetric Bayesian Nash equilibria where voters with the same quality of information use symmetric strategies. That is, we impose the conditions $\sigma_A\left(\theta_\alpha^j\right) = \sigma_B\left(\theta_\beta^j\right)$ and $\sigma_\varnothing\left(\theta_\alpha^j\right) = \sigma_\varnothing\left(\theta_\beta^j\right)$ where $j \in \{H, L\}$.

[15] An alternative assumption that would lead to identical analysis is that policy 0 is implemented with probability λ_A and policy 1 is implemented with probability λ_B, and that independent voters are risk neutral. This could result from probabilistic voting across independent legislative districts.

3 Equilibrium Analysis

Let $\tau_c^\omega(\sigma)$ denote the state-contingent probability, for a given strategy profile σ, that an agent votes for alternative c in state ω.

$$\tau_c^\omega(\sigma) \equiv \frac{1}{2}p + p_I \sum_{\theta\in\Theta} \sigma_c(\theta) \Pr(\theta|\omega, I)$$

In this expression, $\Pr(\theta|\omega, I)$ is the probability that a voter has type $\theta \in \Theta$, conditional on being an independent voter and on ω being the state of the world. The state-contingent probability that an agent abstains in state ω for a given strategy profile σ is then $\tau_\varnothing^\omega(\sigma) = 1 - \tau_A^\omega(\sigma) - \tau_B^\omega(\sigma)$.

Using these probabilities, we can compute the expected payoff of the different actions. It is useful to define the difference in expected payoff between playing a (or b) and abstention for an independent voter of type θ,

$$\begin{aligned} G(a|\theta) \quad = \quad & \Pr(\alpha|\theta) \sum_{i=0}^{n} \sum_{j=0}^{n-i} \Delta_{ij}^a \tfrac{(n-1)!}{i!j!(n-1-i-j)!} \left(\tau_A^\alpha\right)^i \left(\tau_B^\alpha\right)^j \left(\tau_\varnothing^\alpha\right)^{n-1-i-j} && (2) \\ & - (1 - \Pr(\alpha|\theta)) \sum_{i=0}^{n} \sum_{j=0}^{n-i} \Delta_{ij}^a \tfrac{(n-1)!}{i!j!(n-1-i-j)!} \left(\tau_A^\beta\right)^i \left(\tau_B^\beta\right)^j \left(\tau_\varnothing^\beta\right)^{n-1-i-j} \\ G(b|\theta) \quad = \quad & \Pr(\beta|\theta) \sum_{i=0}^{n} \sum_{j=0}^{n-i} \Delta_{ij}^b \tfrac{(n-1)!}{i!j!(n-1-i-j)!} \left(\tau_A^\beta\right)^i \left(\tau_B^\beta\right)^j \left(\tau_\varnothing^\beta\right)^{n-1-i-j} && (3) \\ & - (1 - \Pr(\alpha|\theta)) \sum_{i=0}^{n} \sum_{j=0}^{n-i} \Delta_{ij}^b \tfrac{(n-1)!}{i!j!(n-1-i-j)!} \left(\tau_A^\alpha\right)^i \left(\tau_B^\alpha\right)^j \left(\tau_\varnothing^\alpha\right)^{n-1-i-j} \end{aligned}$$

where Δ_{ij}^a (Δ_{ij}^b) represents the change in policy when a vote for a (b) is added. In the case of majority rule, votes only change the outcomes if they are *pivotal.* That is, $\Delta_{ij}^a = \frac{1}{2}$ whenever there is a tie or B is leading by one vote, and $\Delta_{ij}^a = 0$ otherwise. Analogously, $\Delta_{ij}^b = \frac{1}{2}$ whenever there is a tie or A is leading by one vote, and $\Delta_{ij}^a = 0$ otherwise. Under proportional representation, $\Delta_{ij}^a = \frac{i}{i+j} - \frac{i}{i+j+1}$ if $i + j > 0$ and $\Delta_{ij}^a = \frac{1}{2}$ otherwise; analogously, $\Delta_{ij}^b = \frac{i+1}{i+j+1} - \frac{i}{i+j}$ if $i + j > 0$ and $\Delta_{ij}^b = \frac{1}{2}$ otherwise. Subtracting (3) from (2) we get the difference in expected payoff between playing a and b for an independent voter of type θ, as follows.

$$G(a|\theta) - G(b|\theta) = \Pr(\alpha|\theta) \sum_{i=0}^{n} \sum_{j=0}^{n-i} \left(\Delta_{ij}^{a} + \Delta_{ij}^{b}\right) \tfrac{(n-1)!}{i!j!(n-1-i-j)!} \left(\tau_A^\alpha\right)^i \left(\tau_B^\alpha\right)^j \left(\tau_\varnothing^\alpha\right)^{n-1-i-j} - (1-\Pr(\alpha|\theta)) \sum_{i=0}^{n} \sum_{j=0}^{n-i} \left(\Delta_{ij}^{a} + \Delta_{ij}^{b}\right) \tfrac{(n-1)!}{i!j!(n-1-i-j)!} \left(\tau_A^\beta\right)^i \left(\tau_B^\beta\right)^j \left(\tau_\varnothing^\beta\right)^{n-1-i-j} \quad (4)$$

Equations (2), (3) and (4) are useful to characterize voters best responses. A θ-type voter will vote for A only if $G(a|\theta) \geq \max\{G(b|\theta), 0\}$, will vote for B only if $G(b|\theta) \geq \max\{G(a|\theta), 0\}$ and will abstain only if $0 \geq \max\{G(a|\theta), G(b|\theta)\}$. A useful observation is that the expressions inside the summations in equations (2), (3) and (4) are exactly the same for voters of all types: the only difference across types is the posterior belief $\Pr(\alpha|\theta)$ formed on the basis of their signal. This observation makes clear that highly informed voters should always vote in accordance with their private signals. Suppose, for example, that θ_α^H types vote for B in equilibrium. This implies that $G(b|\theta_\alpha^H) \geq 0$ and $G(b|\theta_\alpha^H) \geq G(a|\theta_\alpha^H)$. If that's the case, given that $\Pr\left(\alpha|\theta_\alpha^H\right) > \Pr\left(\alpha|\theta_\alpha^L\right) > \Pr\left(\alpha|\theta_\beta^L\right) > \Pr\left(\alpha|\theta_\beta^H\right)$, all other types must strictly prefer to vote for B. This is incompatible with any symmetric equilibrium.[16] A similar argument holds for abstention.

Therefore, in order to characterize the equilibria, we just need to pin down the strategies of low information types, θ_α^L and θ_β^L. Following a similar logic to the one in the last paragraph, one can easily show that voters with low levels of information cannot vote against their signals in equilibrium: if $\sigma_B\left(\theta_\alpha^L\right) \geq 0$ then $\sigma_B\left(\theta_\beta^L\right) = 1$, which is inconsistent with any symmetric equilibrium. Hence, $\sigma_B\left(\theta_\alpha^L\right) = 0$ in equilibrium. Analogously, one can also show that $\sigma_A\left(\theta_\beta^L\right) = 0$. As a result, independent voters with low levels of information must mix between voting in line their signals and abstaining. The symmetry assumption guarantees that $\sigma_\varnothing\left(\theta_\beta^L\right) = \sigma_\varnothing\left(\theta_\beta^L\right)$ and $\sigma_A\left(\theta_\alpha^L\right) = \sigma_B\left(\theta_\beta^L\right)$; abusing notation, these probabilities can be denoted simply as σ and $1-\sigma$, respectively. Defined this way, σ then entirely characterizes an equilibrium in this model, as Proposition 1 now states.

[16] That is, if voters of all types vote B then, in response, an individual of type θ_α^H should vote A. Note that symmetry is not essential to this result.

Proposition 1 *In equilibrium, under either electoral rule, it must be that*

(i) highly informed types always vote their signals;

(ii) low types abstain with probability $\sigma \in [0,1]$ and vote their signals with prob. $1-\sigma$.

Since even low-quality signals are informative, it might seem intuitive that everyone should vote, which would imply that $\sigma^* = 0$ in equilibrium. Under majority rule, however, Feddersen and Pesendorfer (1996) point out a strategic incentive for relatively uninformed citizens to abstain, to avoid the *swing voter's curse* of negating the votes of their better-informed peers. Under proportional representation, we show in Herrera et al. (2018) that a *marginal voter's curse* operates similarly, to dissuade poorly informed citizens from casting votes that will dilute the unity of those with superior expertise. Even in PR, then, citizens with the lowest levels of information should abstain in equilibrium. In either electoral system, the value of abstention is the ability to delegate the decision to other independent voters with superior expertise. In both cases, participation increases with the share p of voters who are designated as partisan (or, fixing $p_\varnothing$, decreases in the expected fraction p_I of voters who are independent).

The analysis of Herrera et al. (2018) assumes a continuum of information types, and focuses on large elections. These are realistic features of public elections, but are not feasible for laboratory experiments, which is why the model of Section 2 includes only two information types, and why the experiments below include only $n = 6$ participants in each round. Unfortunately, this prevents an analytical characterization of equilibrium, beyond Proposition 1. To get a sense of how voters behave in equilibrium, therefore, we use a numerical approach. Specifically, we first generate a grid consisting of combinations of parameter values, in the following ranges (in increments of 0.02): $p \in [0,1)$, $p_\varnothing \in [0, 1-p)$, $p_H \in (0,1)$, $q_H \in \left(\frac{1}{2}, 1\right)$, and $q_L \in \left(\frac{1}{2}, q_H\right)$.[17] We set the number of voters $n = 6$, which is the parameter used in the experiments (though using alternative values of n produces similar patterns). For each parameter combination, we then numerically compute the abstention probabilities σ^M and σ^{PR} that maximize expected utility for voters with low levels of information under majority rule and PR, respectively, and take these to be the equilibrium values. This approach relies on McLennan's (1998) observation that, in a common interest environment such as this, behavior that is socially optimal is also

[17] This generates a total of 17,216,052 parameter combinations.

individually optimal. If multiple equilibria exist, this approach amounts to using Pareto dominance as an equilibrium selection criterion.

The results of this numerical exercise exhibit clear patterns that are consistent with the analytical results of Herrera et al. (2018). In most cases, σ^M and σ^{PR} are both corner solutions, taking values 0 or 1. Specifically, this occurs for 98% of the parameter combinations under majority rule and 95% of the parameter combinations under PR. In 82% of the parameter constellations, majority rule and PR produce identical voting, but in all of the remaining 18% of cases, $\sigma^{PR} > \sigma^M$. Thus, the first main result of the numerical analysis is that, consistent with the analytical prediction of Herrera et al. (2018) for large elections, it appears to be universally the case that abstention is weakly higher under PR than under majority rule.

Result 1 $\sigma^{PR} \geq \sigma^M$

Intuitively, the reason that abstention is higher under PR than for majority rule is that mistakes are more costly. Under majority rule, a single mistake can be remedied by a single correct vote for the party with the superior policy position. The same is not true under PR, because vote shares become diluted, so a vote for the majority party has a lower impact on policy than a vote for the minority. As a simple illustration of this, suppose that the superior alternative received three out of four votes, or a 75% vote share. One additional vote for the opposite alternative reduces this vote share to 60% (three out of five), and an additional vote of support brings it back up, but only to 67% (four out of six). Thus, it takes more than one vote to compensate for one mistaken vote. In that sense, mistakes are more permanent in PR than in majority rule, and voters work harder to avoid them.

In the model of Herrera et al. (2018), we show analytically that, holding fixed the fraction of voters who are non-active, abstention in either electoral environment decreases with the fraction of voters who are partisan p (and increases with the fraction p_I who are independent). This is because an independent voter worries less about overruling his peers when they no longer share his preferences. The numerical analysis suggests that the same pattern holds here as well: for every combination of $p_\varnothing$, p_H, q_H, and q_L in the ranges above, abstention probabilities σ^M and σ^{PR} both decrease (weakly) with p.

Result 2 *σ^M and σ^{PR} (weakly) decrease with p.*

In a common interest setting such as this, expected utility can be reinterpreted as social welfare. Since A partisans and B partisans have opposite preferences, and are realized with equal probability, ex ante expected utility reduces simply to the interim expected utility of an independent voter. In Herrera et al. (2018) we show that this is higher under majority rule than under PR, because mistakes in the latter are more costly. In this paper, we find the same result numerically: for every combination of parameters in the ranges above, welfare is indeed higher under majority rule.

Result 3 *Welfare is strictly higher under M than under PR.*

4 The Experiment

4.1 Design

The parameters for the experiment were set to $n = 6$, $p_H = 40\%$, $p_L = 60\%$, $q_H = 95\%$, $q_L = 65\%$, and $p_\varnothing = 10\%$. The treatment variables were $p \in \{0, 25\%, 50\%\}$ and the voting rule, which was either majority rule or proportional representation. Subjects interacted for 40 periods, with identical instructions every time. In each period, subjects interacted in groups of six.

At the beginning of each round, the color of a triangle was chosen randomly to be either blue or red with equal probability. Subjects were not told the color of the triangle, but were told that their goal would be to work together as a group to guess the color of the triangle. Independently, each would observe one ball (a *signal*) drawn randomly from an urn with 20 blue and red balls. With $p_H = 40\%$ probability, a participant would be designated as a *high* type (H), and 19 of the 20 balls in the urn would be the same color as the triangle. With $p_L = 60\%$ probability, a participant would be designated as a *low* type (L), in which case only 13 of the 20 balls would be the same color as the triangle. Individual were told their own types, but did not know the types of the other five members of their group.

After observing their signals, each subject had to take one of three actions: vote Blue, vote Red, or abstain from voting. Regardless of which action they chose, however, they

Treatment	Voting Rule	% Partisans (p)	$\sigma^*_{\varnothing,H}$	$\sigma^*_{\varnothing,L}$
M0	Majority Rule	0	0%	100%
M25	Majority Rule	25	0%	0%
M50	Majority Rule	50	0%	0%
P0	Proportional Representation	0	0%	100%
P25	Proportional Representation	25	0%	100%
P50	Proportional Representation	50	0%	0%

Table 1: Treatments summary and equilibrium abstention rates for low types.

were told that their action choice might be replaced at random, by the choice of a computer: with 10% probability, their vote choice was changed to Abstain. With probability $\frac{p}{2}$ the voting choice was replaced with a Blue vote, and with probability $\frac{p}{2}$ it was replaced with a Red vote. Replacements of votes were determined independently across subjects.

In the Majority Rule (M) treatments, subjects each received payoffs of 100 points if the number of votes for the color of the triangle exceeded the number of votes for the other color, 50 points in case of a tie and 0 points otherwise. In the case of Proportional Representation (P) treatments, subjects each received a payoff in points equal to the percentage of non-abstention votes that had the same color as the triangle—or, if everyone abstained, a payoff equal to 50 points. Table 1 summarizes all treatments.

4.2 Equilibrium Predictions and Hypotheses

For each experimental treatment group, Table 1 lists the equilibrium abstention rates $\sigma^*_{\varnothing,H}$ and $\sigma^*_{\varnothing,L}$ for high- and low-type individuals, derived numerically as explained above. By Proposition 1, voters should never vote against their signals: they should only vote with their signals, or abstain. High-type individuals should always vote, but the equilibrium strategy of low-type voters varies by treatment. Under majority rule, they should abstain when $p = 0\%$ but vote for all higher values of p. Under proportional representation, low-type individuals should vote when $p = 50\%$ but abstain for all lower values of p.[18] We summarize the predictions drawn from Proposition 1 and the numerical analysis in the following hypotheses:

[18]Treatments P0, P25, P50, M25 and M50 have unique equilibrium. In the case of M0, there are two additional Pareto dominated equilibria: (i) a mixed strategy equilibrium where low information types vote their signal with probability of 78% and abstain with a probability of 22%, and (ii) a pure strategy equilibria where all low types vote. In both of these equilibria high types vote their signals (as shown in Proposition 1).

Hypothesis 1 *Low types abstain weakly more than high types.*

Hypothesis 2 *The frequency of abstention by high types does not change with the partisan share or with the voting rule.*

Hypothesis 3 *Under either voting rule, the frequency of abstention by low types weakly decreases with the partisan share.*

Hypothesis 4 *Low types abstain weakly more under PR than under majority rule.*

Hypothesis 5 *The average payoff is higher under majority rule than under PR.*

Hypotheses 1 and 2 are drawn from Proposition 1, while hypotheses 3, 4 and 5 are drawn from the numerical analysis.

4.3 Procedures

Experiments were conducted at the Experimental Economics Laboratory at the University of Valencia (LINEEX) in November 2014. Students interacted through computer terminals, and the experiment was programmed and conducted with the software z-Tree (Fischbacher 2007). All experimental sessions were organized along the same procedure: subjects received detailed written instructions (see Appendix B), which an instructor read aloud. Before starting the experiment, students were asked to answer a questionnaire to check their full understanding of the experimental design. Right after that, subjects played one of the treatments for 40 periods and random matching. Matching occurred within matching groups of 12 subjects, which generated 5 independent groups in each treatment. At the end of each round, each subject was given the information about the color of the triangle, their original and their final vote, and the total numbers of Blue votes, Red votes, and abstentions in their group (though they could not tell whether these were the intended votes of the other participants, or computer overrides). In P treatments, they also observed the percentage of votes that matched the color of the triangle; in M treatments, they instead were told whether the color of the Triangle received more, equal, or fewer votes than the other color. To determine payment at the end of the experiment, the computer randomly selected five periods and participants earned the total of the amount earned in these periods. Points were converted to euros at the rate of 0.025€.

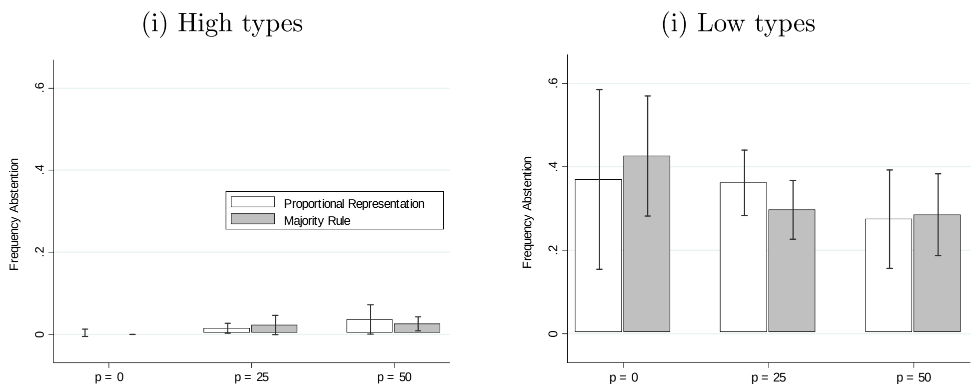

Figure 1: Observed abstention for each treatment, by voter type. The white (gray) bar corresponds to average abstention rate in PR (majority rule). 95% confidence intervals are drawn from regression (1) in Table 4 (in Appendix B).

In total, subjects earned an average of 14.21€, including a show-up fee of 4 Euros. Each experimental session lasted approximately one hour.

5 Experimental Results

This section summarizes the voting behavior observed in the various experimental treatments across all rounds of play. Unless otherwise indicated, behavioral patterns are similar for rounds 21-40, when participants were more experienced with the experiment. We report both parametric and non-parametric tests. All non-parametric tests use averages at the matching group level as their unit of analysis. The regression analysis (summarized in Table 1 in Appendix B) clusters errors at the matching group level, and some specifications control for individual voter characteristics. Figure 1 displays abstention rates for high and low types across treatments. Figures 2 and 3 display differences across partisanship levels and electoral rules, respectively, with confidence intervals based on regressions that control for demographics and other voter characteristics (column 3 of Table 1). We begin by discussing participation patterns for voters with high and low levels of information, for varying levels of partisanship, and then comment on how these patterns differ across electoral systems. We also present results on vote choice conditional on participation, and on average payoffs.

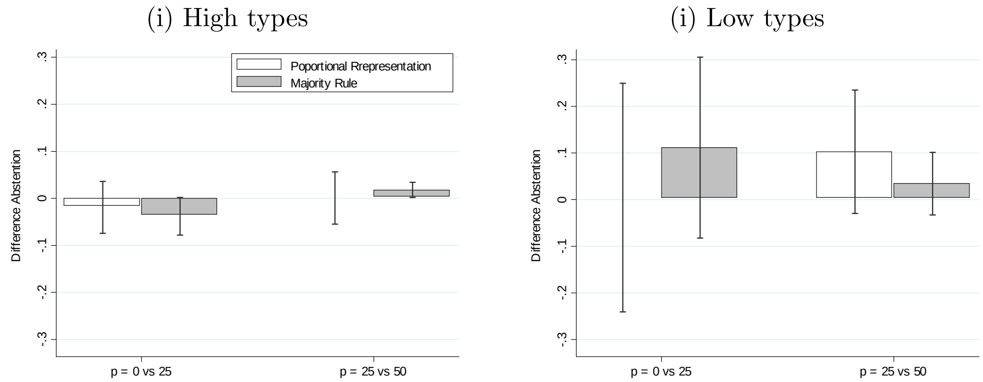

Figure 2: Treatment differences in abstention for different levels of partisans for each voting rule and voter type. The white (gray) bar corresponds to in PR (majority rule). 95% confidence intervals are drawn from regression (3) in Table 4.

Abstention by High Types. According to the equilibrium analysis above, voters with high levels of information should never abstain. As the first panel of Figure 1 makes clear, empirical abstention is indeed extremely low across treatments. 2% of these voters do abstain, however, and a Jonckheere-Terpstra test indicates that abstention also increases with p both for majority rule and for PR (p-values .01 and .02, respectively).[19] This is contrary both to Hypothesis 2 and also to the prediction of the QRE model that we discuss in the following section, and thus remains somewhat puzzling. On the other hand, Figure 2 displays differences in abstention for different levels of partisanship, taken from a regression that controls for individual voter characteristics (column 3 of Table 1). With majority rule, abstention is higher when the partisan share is 50% than when it is 25% (the p-value is 0.075), but other than this case, increasing the partisan share does not change abstention by an amount that is statistically significant, and may even reduce it. Even with no controls, the pattern is not strong: in no case is abstention higher than 3.6%.[20]

Abstention by Low Types. The two panels of Figure 1 show the stark contrast between the abstention rates of voters with high and low levels of information: abstention is only 2% for high types on average, but is 34% for low types. For every treatment,

[19]The Jonckheere-Terpstra test is a non-parametric test for ordered alternatives, i.e., it tests the null hypothesis of $\sigma^{M0}_{\varnothing,H} = \sigma^{M25}_{\varnothing,H} = \sigma^{M50}_{\varnothing,H}$ against the alternative hypothesis of $\sigma^{M0}_{\varnothing,H} \leq \sigma^{M25}_{\varnothing,H} \leq \sigma^{M50}_{\varnothing,H}$ or $\sigma^{M0}_{\varnothing,H} \geq \sigma^{M25}_{\varnothing,H} \geq \sigma^{M50}_{\varnothing,H}$ with at least one strict equality.

[20]The pattern becomes even less pronounced as participants get more experienced. Restricting to rounds 21-40 increases the Jonckheere-Terpstra p-values to .19 for majority rule and .03 for PR.

the difference in participation rates between high and low types is statistically significant (Mann-Whitney, $p < 0.01$). This finding is in line with Hypothesis 1: better informed voters tend to participate more in elections. Existing studies have documented a similar pattern for majority rule (e.g., Battaglini et al., 2008, 2010, Morton and Tyran, 2011, Mengel and Rivas, 2016), but never before for PR (to our knowledge).

While the overall difference between the behavior of high types and low types matches the theoretical prediction above, specific treatments line up less well. As Table 1 shows, equilibrium analysis predicts corner solutions for every treatment, meaning that voters with low information levels should either all vote or all abstain. Empirically, abstention rates are instead moderate in every treatment, ranging from 27% to 43%.[21] This is partly mechanical, as abstention cannot be lower than 0% or higher than 100%, but the magnitude of the departure from theoretical predictions is remarkably large. The difference between high and low types also persists in treatments where it shouldn't: when 50% of the electorate is partisan, for instance, the theoretical prediction is that all voters should vote, whatever the electoral system.

Though levels of participation do not match the theoretical predictions, patterns of participation match rather closely. For the majority rule treatments, empirical abstention percentages are 43%, 30% and 29%; as predicted, most of the decline in abstention occurs between treatments M0 and M25. For the PR treatments, empirical abstention percentages are 37%, 36%, and 27%; as predicted, most of the decline in abstention occurs between treatments P25 and P50. Behavior is sufficiently noisy that, as the second panel of Figure 2 makes clear, none of these individual differences is statistically significant at conventional levels. Overall, however, there is moderately strong evidence that, for either rule, abstention decreases with the level of partisanship, in line with Hypothesis 3. Specifically, a Jonckheere-Terpstra test of the hypothesis that abstention increases with partisanship yields a p-value of .08 for majority rule and .11 for PR. Restricting to rounds 21-40, when participants were more experienced with the game, these fall to .02 and .05, respectively.

[21] Morton and Tyran (2011) find that low-information voters tend to vote less than is optimal. We find the same in treatments M25, M50, and P50, but in treatments M0, P0, and P25, poorly informed voters vote significantly more than predicted by theory.

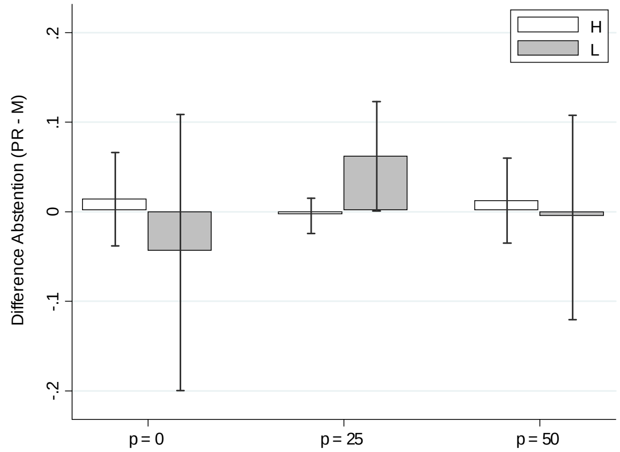

Figure 3: Effect of the rule on the abstention rate for each partisan level and each type of voter. 95% confidence intervals are drawn from regression (3) in Table 4.

Electoral System. When the partisan share is quite low or quite high ($p = 0\%$ or $p = 50\%$), the equilibrium analysis above predicts no difference between electoral systems, either for high types or for low types. Consistent with this, the empirical difference between abstention rates is small, and statistically insignificant at conventional levels (Mann-Whitney, p-value $> .3$ in all cases).[22] For an intermediate level of partisanship ($p = 25\%$), equilibrium analysis predicts higher abstention for low types under PR than under majority rule. Empirically, this difference is indeed positive (6%). With non-parametric tests, this estimate is not statistically significant (Mann-Whitney, p-value $=$ 0.17), but with the regression analysis, this difference becomes strongly significant ($\chi^2_1 =$ 16.8, p-value < 0.001).[23] Treatment effects of the electoral rule (drawn from regression 3 of Table 1) are illustrated in Figure 3, which makes clear that the impact of the electoral rule is statistically significant for low types with moderate partisanship, but not for high types or for high or low levels of partisanship.

Payoffs. Figure 4 displays the average realized payoff in each treatment, together with the theoretical prediction for the realized draws.[24] In every treatment, realized

[22] See also regression (1) in Table 4.

[23] Regression analysis shows no significant differences across voting systems for $p = 0$ or $p = .5$.

[24] The model of Section 2 assumes that A partisans and B partisans have opposite incentives. Since these are realized with equal probability, however, their opposite interests "cancel out" such that, as Section 3 notes, ex ante expected utility reduces to the ex interim expected utility of non-partisans alone. Both for this reason, and to keep the experiment simple, participants were rewarded only for matching the collective outcome to the state, even on occasions when their own votes were selected to be overriden by partisan

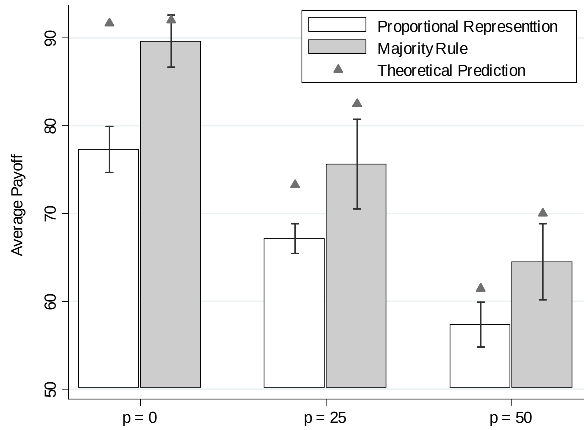

Figure 4: Average payoff for each rule and each level of partisans. 95% confidence intervals are drawn from a linear regression on payoffs, clustered at the matching level.

payoffs fall short of equilibrium values, which is inevitable in that equilibrium behavior maximizes welfare. The loss is relatively small, however, on average amounting to only 8% of the payoff (6% for majority rule and 11% for PR) that voters would have achieved by all playing equilibrium strategies. The pattern of empirical payoffs is consistent with Hypothesis 5: payoffs are higher under majority rule than under PR (Mann-Whitney test, p-values < 0.02 for all levels of partisanship). Payoffs also decrease with the level of partisanship (Jonckheere-Terpstra, p-values < 0.01 for both rules).

Signal Voting. The theory above predicts that, if individuals vote, they should always vote their signals. Empirically, this is indeed what most voters do, although 12% instead vote opposite their own signals.[25] One possible explanation for anti-signal voting is simply that voters make mistakes in computing expected utility, as discussed in the following section. If so, errors should be more frequent when payoffs are more similar across actions. Consistent with this logic, anti-signal voting is more prevalent among low types than high types: 16% versus 5% (Mann-Whitney, p-value < 0.05 for all combinations of rule and p). Moreover, for either electoral rule, occurs more frequently as the level p of partisanship increases (Jonckheere-Terpstra, p-value < 0.05 for all combinations of rule and p).

votes (or non-votes). To be consistent with this, the theoretical predictions displayed in Figure 4 reflect the utility of independent voters alone.

[25] Anti-signal voting has been observed repeatedly in existing experiments on information aggregation. For example, see Guarnaschelli et al (2000), Bouton, Castanheira and Llorente-Saguer (2016) and Bouton, Llorente-Saguer and Malherbe (2017).

6 An Alternative Model with Mistakes

The theoretical benchmark above assumes that subjects do not make mistakes. However, the probability computations involved in determining which action is optimal are rather complicated. Accordingly, this section explores a variation of the model above, in which subjects need not always best-respond. In particular, we apply the concept of *quantal response equilibrium* (QRE) proposed by McKelvey and Palfrey (1995, 1998).[26] The basic idea of this model is that agents make mistakes, and that these mistakes are more frequent when their expected cost is lower. Formally, let $\sigma = (\sigma_1, \sigma_2, ..., \sigma_6)$ be a completely mixed profile of strategies, where $\sigma_i = \{\sigma_{ijk}\}$ and σ_{ijk} is the probability that player i, with type j, votes $k \in \{s, a, c\}$, where s refers to voting with their signal, a refers to abstention and c refers to voting contrary to their signal. Let $\overline{u}_{ijk}(\sigma)$ denote the expected utility to player i from taking action k when her type is j, given σ. Then σ^* is a logit quantal response equilibrium if and only if

$$\sigma^*_{ijk} = \frac{e^{\lambda \overline{u}_{ijk}(\sigma)}}{\sum_l e^{\lambda \overline{u}_{ijl}(\sigma)}}$$

for all i, j, and k, where $\lambda > 0$ is a free parameter that captures the sophistication (or level of rationality) of the agents. When $\lambda = 0$, voters of all types assign equal probability to the three actions, regardless of the electoral rule or the partisanship of the rest of the electorate. For intermediate values of λ, subjects assign higher probability to the best response to the empirical behavior of other voters, but make mistakes with a probability that decreases with the payoff difference between the best response and an alternative action. As $\lambda \to \infty$, QRE converges to the Nash equilibrium of the game.

Figure 5 shows the predictions for the various treatments and voter types for different levels of λ. This exhibits patterns that are not in the original model but do match the data. For example, the original model predicts that voters with low levels of information should abstain with probability zero or probability one, but QRE instead predicts levels of abstention close to 50%, even for relatively high levels of λ. This implies smoother comparative statics than the ones produced by the Nash equilibrium. As highlighted above, this more closely describes participants' empirical behavior. QRE also predicts

[26] Existing applications of QRE to voting include Guarnaschelli, McKelvey and Palfrey (2000), Goeree and Holt (2005), Levine and Palfrey (2007), Großer and Schram (2010) and Kamm and Schram (2014).

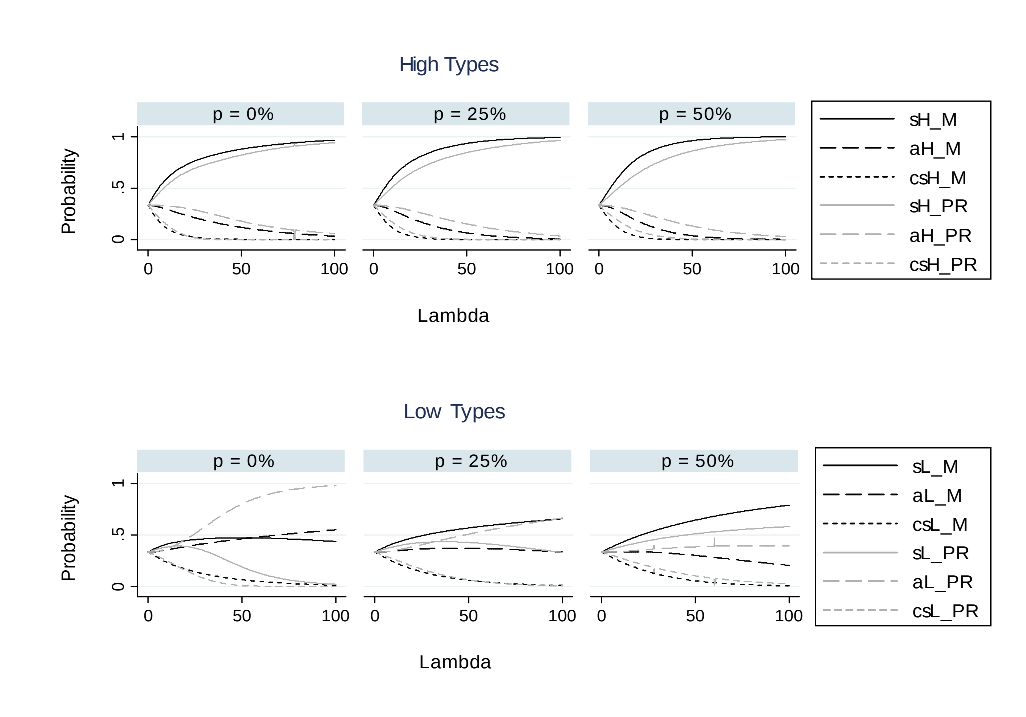

Figure 5: QRE predictions for each level of partisans, voting rule and voter type as a function of the rationality parameter λ. The different lines are indicated as xY_Z; where x indicates the action (i.e., voting with the private signal s, abstaining a, or voting contrary to the signal c), Y refers to the type of voter (i.e., high H or low L), and Z refers to the voting rule (MR or PR).

that high types will vote in line with their signals with probability close to, but strictly less than one. This, too, matches the results of the experiment, where, on average, high types voted according to their signal 97% of the time. The QRE model also generates comparative statics with respect to voting against the signal: high types should make this mistake less frequently than low types, and both types should vote against their signals more frequently when the partisan share p is higher (as reported in the previous section). One feature of the data that QRE does not seem to explain is that, as the previous section notes, high types abstain more as partisanship increases. Figure 5 makes clear that QRE generates the opposite pattern: high types should abstain less frequently as the partisan share increases. Other than this finding, however, QRE seems to offer a unified explanation for the various empirical patterns described in previous section.

7 Conclusion

This paper has reported the results of the first laboratory experiment on common interest PR elections. The central finding is that some voters abstain, even though all receive informative private signals, and voting is costless. In doing so, voters withhold their private information but actually improve the collective decision, by shifting weight to the signals of voters who are better informed. Similar behavior has been observed in existing experiments for majority rule, but may be surprising here given the dissimilarity of the marginal and the pivotal voting inferences. In fact, abstention is actually higher under PR than under majority rule. This is as predicted by theory, since mistakes are more permanent under PR, and therefore more costly. Otherwise, behavioral patterns for the two rules are quite similar. Most of the empirical patterns in voter behavior match the theoretical predictions of Nash equilibrium, and most of the remaining patterns match an augmented model where voters sometimes make mistakes in computing expected utility.

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Appendix

Appendix A: Questionnaire Data

In this section we describe the data collected in the questionnaire at the end of the experiment (see Table 2) and show how these vary across treatments (see Table 3). Variables Party and Religion were not included in the regressions in Appendix B since there was no obvious way to aggregate them.

Variable	Description
Gender	Female $= 1$; Male $= 0$
Age	Age in years
Economics	$= 1$ if the major is Economics. Originally, this was a categorical variable with the options "Law" (4.17%), "Economics" (35.28%), "Philology / Literature" (0%), "Physics/Chemistry/Biology" (1.39%), "Engineering" (13.89%), "History" (0.83%), "Politics" (0.28%), "Mathematics" (0.28%), "Others" (43.89%).
Year	Years of studies.
Religiosity	Degree of religiosity. Likert scale from 1 to 4.
Religion	Categorical variable: Christian (56.11%), Hinduist (0.56), Muslim (0.56), No religion (35.56), Other Religion (1.39), Prefer not to answer (5.83). Not included in the regressions.
Politics	Interest in Politics. Likert scale from 1 to 4.
Party	Categorical variable: Podemos (23.33%), PP (17.22%), PSOE (8.06%), UPvD (4.72%), EUPV-EV (3.06%), Primavera (0.83%), Others (16.11%), Dk/Na (26.67%) Not included in the regressions.
Risk	Tendency to take risks. Likert scalefrom 1 to 5.
Trust	Tendency to trust people. Likert scale from 1 to 5.
Experiments	$= 1$ if the subject has participated in 4 or more experiments. Originally, this was a categorical variable about participation in previous experiments: “Never”, “1-3”, “4-6”, and “More than 6”.
Siblings	Number of siblings.

Table 2: Description of variables in the questionnaire data.

	M0	M25	M50	P0	P25	P50	p-value
Gender	0.47	0.57	0.45	0.55	0.58	0.50	0.602
Age	22.25	21.42	21.02	21.57	21.42	21.18	0.213
Economics	0.40	0.43	0.35	0.23	0.35	0.35	0.224
Year	3.83	3.20	3.03	3.52	3.27	3.30	0.014
Religiosity	1.57	1.72	1.75	1.57	2.07	1.90	0.498
Politics	2.42	2.67	2.53	2.57	2.67	2.67	0.243
Risk	3.20	3.52	3.25	3.47	3.25	3.42	0.409
Trust	2.88	2.67	2.67	2.58	2.52	2.57	0.254
Experiments	2.35	2.18	2.30	2.25	2.20	2.37	0.800
Siblings	1.45	1.35	1.33	1.30	1.38	1.55	0.243

Table 3: Summary statistics by treatment group. The last column reports the p-value of an F-test of equality across treatments.

Appendix B: Regressions on Abstention

Variables	(1)	(2)	(3)
dH_MR_0	0.000	-0.002	-0.005
	(0.000)	(0.009)	(0.014)
dH_MR_25	0.023	0.031***	0.033***
	(0.011)	(0.006)	(0.006)
dH_MR_50	0.026**	0.015	0.015
	(0.008)	(0.011)	(0.009)
dH_PR_0	0.004	0.009	0.009
	(0.004)	(0.010)	(0.020)
dH_PR_25	0.015*	0.027***	0.028**
	(0.006)	(0.006)	(0.009)
dH_PR_50	0.036*	0.025	0.028
	(0.017)	(0.020)	(0.025)
dL_PR_0	0.369**	0.375**	0.374**
	(0.101)	(0.096)	(0.089)
dL_PR_25	0.362***	0.370***	0.370***
	(0.037)	(0.039)	(0.039)
dL_PR_50	0.275***	0.268***	0.267***
	(0.055)	(0.052)	(0.053)
dL_MR_0	0.426***	0.425***	0.419***
	(0.067)	(0.069)	(0.069)
dL_MR_25	0.297***	0.306***	0.308***
	(0.033)	(0.030)	(0.030)
dL_MR_50	0.285***	0.271***	0.273***
	(0.046)	(0.045)	(0.044)
Gender		-0.105***	-0.099***
		(0.009)	(0.005)
Age		-0.010*	-0.017**
		(0.004)	(0.004)
Experiments		0.045*	0.037**
		(0.016)	(0.012)
Other controls	No	No	Yes
Observations	14,400	14,400	14,400
R-squared	0.333	0.350	0.359

Table 4: Linear regression of the probability of abstention on a number of dummies indicating the interaction between voter type, voting rule, and level of partisanship.

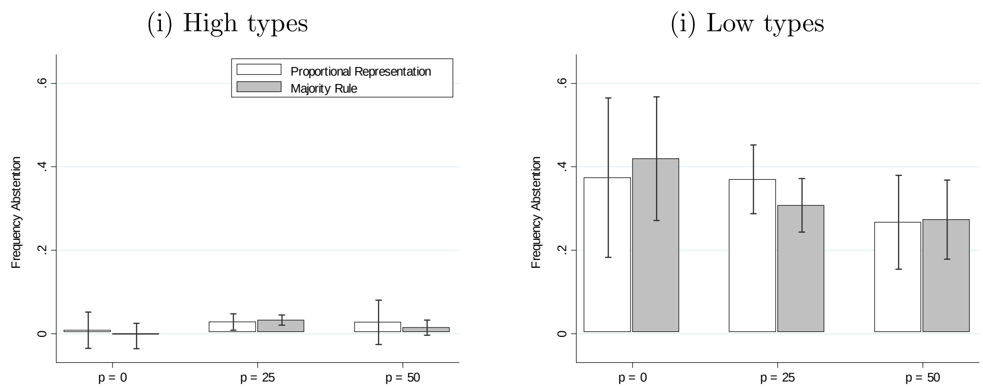


Figure 6: Observed abstention for each treatment, by voter type. The white (gray) bar corresponds to average abstention rate in PR (majority rule).The 95% confidence intervals are drawn from regression (3) reported in Table 4.

Appendix C. Instructions for the Experiment

Welcome and thank you for taking part in this experiment. Please remain quiet and switch off your mobile phone. It is important that you do not talk to other participants during the entire experiment. Please read these instructions very carefully; the better you understand the instructions the more money you will be able to earn. If you have further questions after reading the instructions, please give us a sign by raising your hand out of your cubicle. We will then approach you in order to answer your questions personally. Please do not ask aloud.

During the experiment all sums of money are listed in ECU (for Experimental Currency Unit). Your earnings during the experiment will be converted to euros at the end and paid to you in cash. The exchange rate is 40 ECU = 1€. The earnings will be added to a participation payment of 4€.

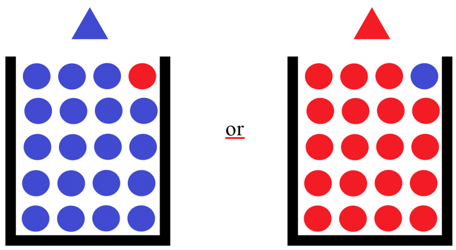
At the beginning of this experiment, participants will be randomly and anonymously divided into sets of 12 participants. These sets remain unaltered for the entire experiment, but you will never be told who is in your set. The experiment is divided into 40 rounds. The rules are the same for all participants and for all rounds. In each round, participants in each set are divided into two groups of 6 participants. In a given round you will only interact with the participants in your group for that round. The earnings in each round will depend partly on your own decision, partly on the decisions of the other participants in your group, and partly on chance.

The Triangle Color. There is a triangle, and at the beginning of each round, the color of the triangle will be chosen randomly. With **50%** probability it will be blue ▲, and with **50%** probability it will be red ▲. You will not know the color of the triangle, but each member of your group will receive a hint. Your objective as a group will be to guess the color of the triangle.

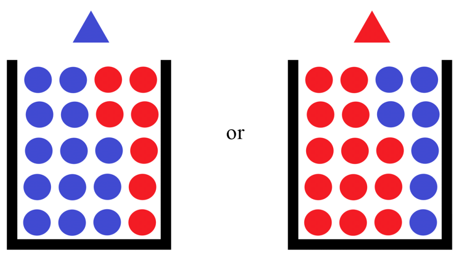
Types. As a hint of the color of the triangle, each group member will observe the color of one ball, drawn from an urn filled with 20 red and blue balls. First, however, each group member will be assigned a type: with **40% probability** you will be designated as **Type B** and will receive a big hint; with **60% probability**, you will be designated as **Type S** and will receive a small hint. Types will be assigned independently for each member of the group, so you and the other members of your group might have different types. You will learn your own type, but will not know the types of the other members of your group.

Big Hints. If your type is Type B, you will receive a big hint. First, an urn will be filled with **19 balls** that are the same color as the triangle, and **1 ball** of the opposite color (a total of

20 balls). If the triangle is blue ▲, for example, then the urn will be filled with 19 blue balls and 1 red ball. If the triangle is red ▲, the urn will be filled with 1 blue ball and 19 red balls. As a Type B individual, you will observe the color of one ball, drawn randomly from this urn. If other members of your group are designated as Type B, they will also observe one ball from this same urn. They might observe the same ball you observed, or a different ball.



Small Hints. If your type is Type S, you will receive a small hint. First, an urn will be filled with **13 balls** that are the same color as the triangle, and **7 balls** of the opposite color (a total of 20 balls). If the triangle is blue ▲, for example, then the urn will be filled with 13 blue balls and 7 red balls. If the triangle is red ▲, the urn will be filled with 7 blue ball and 13 red balls. As a Type S individual, you will observe the color of one ball, drawn randomly from this urn. If other members of your group are designated as Type S, they will also observe one ball from this same urn. They might observe the same ball you observed, or a different ball.



Your Voting Decision. Your voting decision is one of three options: (1) vote Blue, (2) vote Red, or (3) Abstain from voting.

Regardless of your decision (vote Blue, vote Red, or Abstain), your choice might be changed with some probability:

• With a probability of **65%** (or 13 out of 20) your voting decision choice will be maintained.

• With a probability of **10%** (or 1 out of 10) your voting decision will be replaced by a computer who will **Abstain**.

• With a probability of 12.5% (or 1 out of 8) your voting decision will be replaced by a computer who will vote **Blue**.

• With a probability of 12.5% (or 1 out of 8) your voting decision will be replaced by a computer who will vote **Red**.

At the end of each round you will be told whether your voting decision was maintained or replaced. If your vote is replaced, you will also be told how a computer voted in your place.

The other members of your group will cast votes in the same fashion, and like you, their votes might randomly be replaced by computers. At the end of each round, you will see the final vote cast by each of your group members, but you will not be told whether their original vote choices were replaced by computers or not.

Your Payoff. Your payoff in a given round will be the same for all members in your group. Your payoff will depend **only** on the numbers of Blue and Red votes in your group (and **not** on the number of abstentions).

[P]

• If the color of the triangle receives **more** votes than the other color, your payoff will be **100**.

• If the color of the triangle receives **fewer** votes than the other color, your payoff will be **0**.

• If the color of the triangle and the other color receive **equal** numbers of votes, your payoff will be **50**.

Example 1: Suppose that the triangle is red ▲ and that there are 3 Blue votesand 2 Red votes. Since there are fewer votes for the color of the triangle than for the other color, your payoff is 0 ECUs.

Example 2: Suppose that the triangle is red ▲ and that there are 0 Blue votes and 2 Red votes. Since there are more votes for the color of the triangle than for the other color, your payoff is 100 ECUs.

The following table lists your payoff, for any possible combination of Blue and Red votes.

Number of votes for the other color

Number of votes for the color of the triangle		0	1	2	3	4	5	6
	0	50	0	0	0	0	0	0
	1	100	50	0	0	0	0	
	2	100	100	50	0	0		
	3	100	100	100	50			
	4	100	100	100				
	5	100	100					
	6	100						

[M]

Your payoff in will be the **percentage** of votes that have the **same** color as the triangle (if this percentage is not an entire number, the payment will be rounded to the closest entire number). If there are no votes (because everyone abstains) then your payoff is 50.

Example 1: Suppose that the triangle is red ▲ and that there are 3 Blue votes and 2 Red votes. Since 40% (i.e. two out of five) of the votes match the color of the Triangle, your payoff is 40.

Example 2: Suppose that the triangle is red ▲ and that there are 0 Blue votes and 2 Red votes. Since 100% (i.e. two out of two) of the votes match the color of the Triangle, your payoff is 100.

The following table lists your payoff, for any possible combination of Blue and Red votes.

Information at the end of each Round. Once you and all the other participants have made your choices and these choices have been randomly replaced (or not), the round will be over. At the end of each round, you will receive the following information about the round: the color of the triangle, your vote, and the total numbers of Blue votes, Red votes, and abstentions in your group. You will also observe [M: the percentage of votes that match the color of the Triangle, and] [P: whether the color of the Triangle received more, equal or fewer votes than the other color, and] the payoff for your group.

Final Earnings. After the 40 rounds are over, the computer will randomly select 5 of the 40 rounds and you will receive the rewards that you had earned in each of those rounds. Each of the 40 rounds has the same chance of being selected.

Number of votes for the other color

Number of votes for the color of the triangle	0	1	2	3	4	5	6
0	50	0	0	0	0	0	0
1	100	50	33	25	20	17	
2	100	67	50	40	33		
3	100	75	60	50			
4	100	80	67				
5	100	83					
6	100						

Control Questions. Before starting the experiment, you will have to answer some control questions in the computer terminal. Once you and all the other participants have answered all the control questions, Round 1 will begin.

Questionnaire. After the experiment, we will ask you to complete a short questionnaire, which we need for the statistical analysis of the experimental data. The data of the questionnaire, as well as all your decisions during the experiments will be anonymous.