

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

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Abstract

This paper reports the first laboratory experiment of common-value Proportional Representation (PR) elections, and compares these with majority rule. Levels of abstention do not closely match the equilibrium point predictions, but behavioral patterns match all of the major comparative statics. Abstention occurs in both electoral systems even though voting is costless, and is highest for those with lower levels of information. This withholds information but, as long as the electorate is not too ideological, nevertheless improves the collective decision, by raising the average informativeness of the votes that are cast. Abstention is similar under both electoral systems, but for moderate levels of partisanship, abstention is higher under PR. Across treatments, welfare under PR is lower. Finally, as the electorate becomes more ideological, both abstention and welfare decrease.

JEL classification: C92, D70

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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 also provides a useful perspective on 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 value* models of elections, meaning that voters have common information, but derive idiosyncratic utilities from various policy

¹See 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.

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

³See 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.

⁴See Schram and Sonnemans (1996), Herrera, Morelli and Palfrey (2014), and Kartal (2015b) for experimental comparisons of these two institutions. Other examples of papers studying 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 comprehensive survey of this literature, see Palfrey (2015) and Kamm and Schram (2016).

outcomes. This paper documents the first laboratory experiment (to our knowledge) that instead implements a *common value* 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 empirical and theoretical reasons. It is important empirically, as 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 also important theoretically, since the private and common value paradigms make opposite predictions regarding turnout.⁶

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 sunk⁸, and has been successfully reproduced in laboratory experiments.⁹ In a recent paper, however, Herrera et al. (2016) point out that because it relies on the pivotal voting calculus, the swing voter's curse only applies to majority

⁵For 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.

⁶Herrera, Morelli, and Palfrey (2014) show that, as long as support for two opposing sides is not precisely balanced, turnout in a private-value model should be higher under PR than under majority rule, while in the common-value model of Herrera, Llorente-Saguer, and McMurray (2016), however find the opposite: PR gives voters a stronger reason to abstain. For similar private value models, see also Faravelli and Sanchez-Pages (2014), Kartal (2015a) and Herrera, Morelli and Nunnari (2015).

⁷The common-value assumption, which traces back to Condorcet (1785), is important because voters with better information are only useful if they share a voter's own preferences. For a detailed discussion of this assumption, see McMurray (2017a). The common-value 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 contributions 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.

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

⁹Battaglini, 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 (2016) show that abstention also takes place in a setting with endogenous information.

rule, and cannot explain abstention in PR elections. That paper identifies a different rationale for abstention that applies to PR only, 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 are just as prevalent under PR, as well.¹¹

This paper begins by developing a new model, similar in spirit to Herrera et al. (2016), but with only a finite number of voters, and with only two information levels (both of which are strictly positive). We confirm numerically that the two models exhibit the same relationship between information, partisanship, participation, and the electoral rule. We then test the model's theoretical predictions using a laboratory experiment with a 2x3 between-subjects design, varying both the voting rule and the partisan makeup or private value share of the electorate. Perhaps not surprisingly given the complexity of the experiment, the levels of voting and abstention by laboratory participants do not closely match the point predictions of the equilibrium analysis. However, the patterns of participation are exactly in line with the comparative static predictions of the model. Most notably, abstention is paramount even though voting is costless: mildly informed voters abstain in PR elections just as they do in majority rule, in spite of the dissimilarity of the marginal and the pivotal voting inferences. In fact, for intermediate levels of partisanship, abstention is higher under PR than under majority rule, as predicted. As in majority rule, abstention in PR is limited to those with low levels of information: virtually all of those with high quality information vote. Also, abstention decreases with the level of partisanship, as voters become less able to trust others to make decisions on their behalf, and welfare decreases accordingly. The theoretical analysis also makes the subtle prediction that, under PR, mistaken votes have harsher consequences; in line with this, realized welfare for laboratory participants is lower overall under PR than under majority rule.

¹⁰For example, see Sobrio and Navarra (2010) and Riambau (2015).

¹¹In the 2011 Peruvian national election, for example, 11% of the 20 million registered voters abstained entirely and 12% more failed to cast valid votes for the majoritarian presidential election, but 23% also failed to cast valid votes in the PR congressional election, and 39% failed to cast valid votes in the PR election for Andean parliament.

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_\emptyset , p and $p_I = 1 - p_\emptyset - p$. *Non-active voters* cannot vote, and are completely passive.¹² 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

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

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 .¹³ 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 designed 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

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

¹²This 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 .

¹³Partisans 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 \emptyset 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 $x(a, b) = 0\lambda_A + 1\lambda_B = \lambda_B$, ranging continuously from 0 to 1.¹⁴ 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 $\sigma : \Theta \rightarrow \Delta\{a, b, \emptyset\}$ a strategy profile. In the subsequent analysis we use $\sigma_c(\theta)$ to denote the probability that an independent voter of type θ plays c . We focus on symmetric Bayesian Nash equilibria where voters with the quality of information use symmetric strategies. That is, we impose the conditions $\sigma_A(\theta_\alpha^j) = \sigma_B(\theta_\beta^j)$ and $\sigma_\emptyset(\theta_\alpha^j) = \sigma_\emptyset(\theta_\beta^j)$ where $j \in \{H, L\}$.

¹⁴An 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, as in Levy and Razin (2015).

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 $\tau_\emptyset^\omega(\sigma) = 1 - \tau_A^\omega(\sigma) - \tau_B^\omega(\sigma)$.

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 ,

$$G(a|\theta) = \Pr(\alpha|\theta) \sum_{i=0}^n \sum_{j=0}^{n-i} \Delta_{ij}^a \frac{(n-1)!}{i!j!(n-1-i-j)!} (\tau_A^\alpha)^i (\tau_B^\alpha)^j (\tau_\emptyset^\alpha)^{n-1-i-j} \quad (2)$$

$$- (1 - \Pr(\alpha|\theta)) \sum_{i=0}^n \sum_{j=0}^{n-i} \Delta_{ij}^a \frac{(n-1)!}{i!j!(n-1-i-j)!} (\tau_A^\beta)^i (\tau_B^\beta)^j (\tau_\emptyset^\beta)^{n-1-i-j}$$

$$G(b|\theta) = \Pr(\beta|\theta) \sum_{i=0}^n \sum_{j=0}^{n-i} \Delta_{ij}^b \frac{(n-1)!}{i!j!(n-1-i-j)!} (\tau_A^\beta)^i (\tau_B^\beta)^j (\tau_\emptyset^\beta)^{n-1-i-j} \quad (3)$$

$$- (1 - \Pr(\alpha|\theta)) \sum_{i=0}^n \sum_{j=0}^{n-i} \Delta_{ij}^b \frac{(n-1)!}{i!j!(n-1-i-j)!} (\tau_A^\alpha)^i (\tau_B^\alpha)^j (\tau_\emptyset^\alpha)^{n-1-i-j}$$

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 $\Delta_{ij}^b = 0$ 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.

$$\begin{aligned}
G(a|\theta) - G(b|\theta) &= \Pr(\alpha|\theta) \sum_{i=0}^n \sum_{j=0}^{n-i} \left(\Delta_{ij}^a + \Delta_{ij}^b \right) \frac{(n-1)!}{i!j!(n-1-i-j)!} (\tau_A^\alpha)^i (\tau_B^\alpha)^j (\tau_\emptyset^\alpha)^{n-1-i-j} \\
&\quad - (1 - \Pr(\alpha|\theta)) \sum_{i=0}^n \sum_{j=0}^{n-i} \left(\Delta_{ij}^a + \Delta_{ij}^b \right) \frac{(n-1)!}{i!j!(n-1-i-j)!} (\tau_A^\beta)^i (\tau_B^\beta)^j (\tau_\emptyset^\beta)^{n-1-i-j}
\end{aligned} \tag{4}$$

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 $\max\{G(a|\theta), G(b|\theta)\} \leq 0$.

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 $\Pr(\alpha|\theta_\alpha^H) > \Pr(\alpha|\theta_\alpha^L) > \Pr(\alpha|\theta_\beta^L) > \Pr(\alpha|\theta_\beta^H)$, all other types must strictly prefer to vote for B . This is incompatible with any symmetric equilibrium.¹⁵ 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 *it cannot be that lowly informed types vote against their signal*: if $\sigma_B(\theta_\alpha^L) \geq 0$, then $\sigma_B(\theta_\beta^L) = 1$, which is inconsistent with any symmetric equilibrium. Hence, $\sigma_B(\theta_\alpha^L) = 0$ in equilibrium. Analogously, one can also show that $\sigma_A(\theta_\beta^L) = 0$. As a result, independent voters with low levels of information must mix between voting their signal and abstaining. The symmetry assumption guarantees that $\sigma_\emptyset(\theta_\beta^L) = \sigma_\emptyset(\theta_\alpha^L)$ and $\sigma_A(\theta_\alpha^L) = \sigma_B(\theta_\beta^L)$; 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.

Proposition 1 *In equilibrium, it must be that*

(i) *highly informed types always vote their signal;*

¹⁵That 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.

(ii) *lowly informed types abstain with probability $\sigma \in [0, 1]$ and voting their signal with probability $1 - \sigma$.*

Since even low-quality signals are informative, it might seem intuitive that everyone should vote, which would imply that $\sigma^* = 0$ in equilibrium. Since Feddersen and Penderfer (1996) it has been recognized, however, that relatively uninformed citizens have a strategic incentive to abstain under majority rule, 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. (2016) that the *marginal voter's curse* operates 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 fact, that paper shows that turnout is lower in PR elections than under majority rule, essentially because mistakes are more costly: under majority rule, the negative impact of a mistaken vote can be offset by a single correct vote for the superior party; in PR systems, a negative vote dilutes the pool of votes in a way that requires more than one vote to repair.¹⁶ 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_{\emptyset} , decreases in the expected fraction p_I of voters who are independent).

The analysis of Herrera et al. (2016) 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): $p \in [0, 1)$, $p_{\emptyset} \in [0, 1 - p)$, $p_H \in (0, 1)$, $q_H \in (\frac{1}{2}, 1)$, and $q_L \in (\frac{1}{2}, q_H)$.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

¹⁶If three citizens vote for the superior party but a fourth does not, for example, then that party's vote share drops from 100% to 75%, and a fifth vote can only increase this to 80%.

¹⁷This generates a total of 17,216,052 observations.

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. Actually, this approach determines the value of σ that is *socially* optimal, not individually optimal, but McLennan (1998) points out that, in common-value environments such as this, the two are one and the same.¹⁸

The results of this numerical exercise exhibit clear patterns that are consistent with the analytical results of Herrera et al. (2016). 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. (2016) for large elections, it appears to be universally the case that abstention is weakly higher under PR than under majority rule.

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

As noted above, we show analytically in the model of Herrera et al. (2016) 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). The numerical analysis suggests that the same is true here: σ^M and σ^{PR} both increase (weakly) with p for every combination of p_\emptyset , p_H , q_H , and q_L .

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

As explained above, the intuition for Result 1 is that mistakes are more costly under PR, so voters try harder to avoid them. As a corollary to this, we show in the model of Herrera et al. (2016) that expected utility is higher under majority rule than under PR. With common values, expected utility can also be reinterpreted as social welfare. In this paper, this can be computed numerically for any combination of parameters. In every case, welfare is higher under majority rule.

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

¹⁸It may be that there are multiple equilibria; if so, this approach amounts to using Pareto dominance as an equilibrium selection mechanism.

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 $p_\emptyset = 10\%$. 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 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 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.

Treatment	Voting Rule	% Partisans (p)	$\sigma_{\emptyset,H}^*$	$\sigma_{\emptyset,L}^*$
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.

4.2 Equilibrium Predictions and Hypotheses

For each experimental treatment group, Table 1 lists the equilibrium abstention rates $\sigma_{\emptyset,H}^*$ and $\sigma_{\emptyset,L}^*$ 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 . We summarize these predictions in the following hypotheses:

Hypothesis 1 *High types should vote (weakly) more than low types.*

Hypothesis 2 *The frequency of abstention of high types should not change with the number of partisans or with the voting rule.*

Hypothesis 3 *Under either voting rule, the frequency of abstention of low types decreases with the number of partisans.*

Hypothesis 4 *The frequency of abstention of low types is weakly lower under majority rule than under PR.*

Hypothesis 5 *Average Payoff is higher under majority rule than under PR.*

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

5 Experimental Results

This section summarize the voting behavior observed in the various treatments, averaging across subject matching groups. In the following, we only report results for the second half of the experiment (rounds 21-40), in order to allow for learning in the initial periods. Unless stated, the results are robust to considering the whole data set. All of the non-parametric tests that we refer to use averages at the matching group level as their unit of analysis.

Abstention by High Types. We begin by discussing voter participation. Empirical abstention rates for each treatment are displayed in Figure 1, for voters of high and low types. According to the theoretical predictions, high type voters should never abstain. Empirically, abstention is indeed extremely low in all treatments (2% on average, both for majority rule and PR). In PR treatments, we cannot reject the null hypothesis that

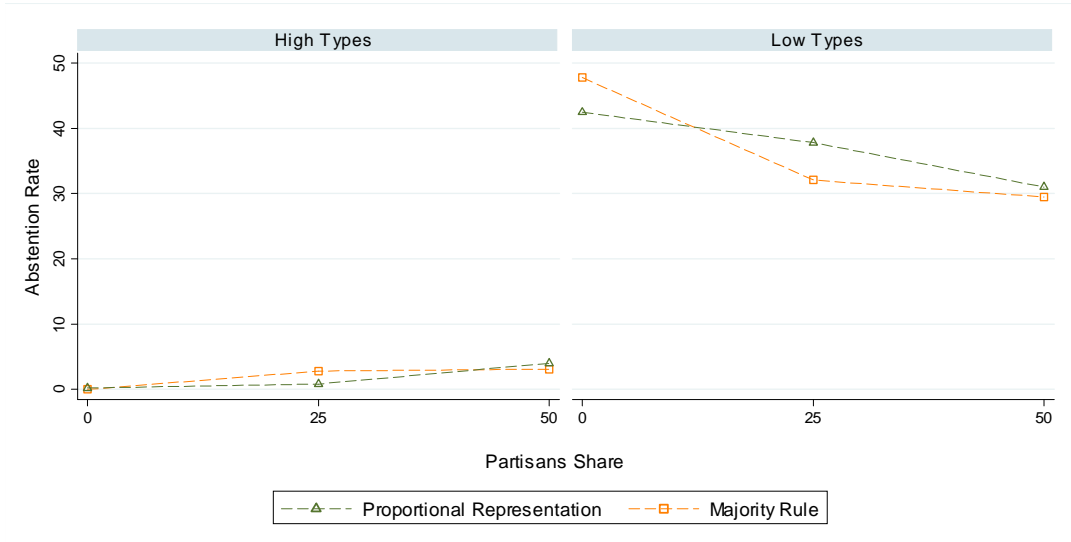


Figure 1: Observed abstention for each treatment, by voter type.

the frequency of abstention across high-type voters is constant with the level of partisans in the electorate (Jonckheere-Terpstra, p -value = 0.19), in line with Hypothesis 2.¹⁹ We do find a significant increase (Jonckheere-Terpstra, p -value = 0.03) in M treatments, but abstention is never higher than 3%.²⁰

Abstention by Low Types. Figure 1 highlights a stark contrast in behavior across voter types: while the average frequency of abstention is less than 2% for high types, it is 34% for low types. For every treatment, the difference in participation rates between high and low types is statistically significant (Mann-Whitney, $p < 0.01$). This finding is line with Hypothesis 1: better informed voters tend to participate more in elections. Existing studies have documented similar behavior for majority rule (e.g., Battaglini et al., 2008, 2010, Morton and Tyran, 2011, Mengel and Rivas, 2016), but never before (to our knowledge) for PR.

While the general distinction between the behavior of high and low types matches the theoretical predictions, the behavior in specific treatments lines up less well. For one thing, as Table 1 shows, equilibrium analysis predicts corner solutions in all treatments: that is, low types should either all abstain or all vote. In contrast with this, empirical

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

²⁰If we consider all periods, we also find a significant trend under PR treatments (Jonckheere-Terpstra, p -value = 0.02)

abstention rates are moderate. Moreover, for certain treatments, the predictions for high and low types are actually the same: when the fraction of voters who are partisan is 50%, for instance, high- and low-types of voters should all vote, in either electoral system.²¹

While the levels of abstention in individual treatments clearly differ from the equilibrium predictions, the patterns of abstention evident in Figure 1 line up more squarely with comparative static predictions. In particular, the biggest empirical changes in voting behavior coincide exactly with the biggest changes in predicted voting behavior. For the majority rule treatments M0, M25, and M50, respectively, abstention percentages are 48%, 32% and 29%; as predicted, the largest difference is between M0 and M25. For the proportional representation treatments P0, P25, and P50, the corresponding percentages are 42%, 38%, and 31%; as predicted, the largest difference is between P25, and P50. For both electoral rules, we can reject the null hypothesis that the level of abstention is constant across different levels of partisanship in favor of the alternative hypothesis that abstention decreases with the level of partisans (Jonckheere-Terpstra, p -value = 0.051 and 0.020 respectively), in line with Hypothesis 3.²²

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, $p > 0.3$ in all cases). For an intermediate level of partisanship ($p = 25\%$), equilibrium analysis predicts higher abstention under PR than under majority rule. Empirically, this difference is not statistically significant (Mann-Whitney, p -value = 0.17), but the point estimate is indeed positive (6%). Moreover, this difference becomes strongly significant ($\chi_1^2 = 16.8$, $p < 0.001$) in the regression analysis summarized in Table 2 in Appendix A.²³

Voting behavior. So far, this section has focused solely on abstention. According to

²¹Morton and Tyran (2011) find that low information voters tend to vote less than it is optimal. This is in line with what we find in treatments with M25, M50 and P50. In the other treatments, however, we find the opposite effect: low informed voters vote significantly more than predicted by theory. The latter is, in part, due to the ceiling effect. However, the magnitude of the departure is remarkably large.

²²If we consider all periods, the trend becomes marginally insignificant under PR (Jonckheere-Terpstra, p -value = 0.11). They are robust under M treatments.

²³Regression analysis shows no significant differences across voting systems for other levels of partisanship ($p = 0$ or $p = 50\%$).

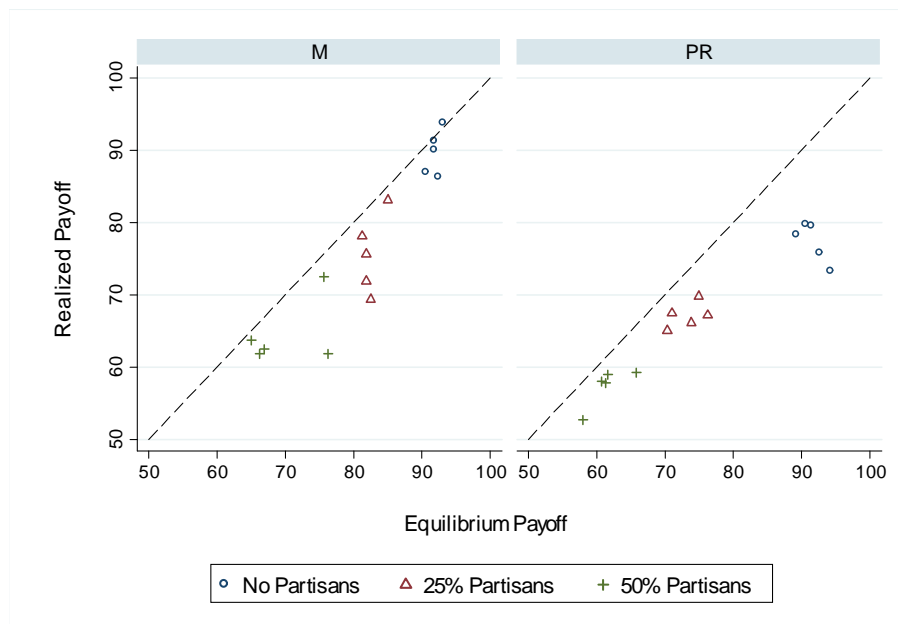


Figure 2: Realized payoff vs equilibrium payoff in each independent group.

theory, voters who don't abstain should always vote their signals. Empirically, most voters do vote their signals, but not all: 12% vote opposite their own signals.²⁴ One possible explanation for this is simply that voters make mistakes in computing expected utility, as in a quantal response equilibrium.²⁵ If so, errors should be more frequent when payoffs are more similar across actions; consistent with this, high types are less likely empirically to vote against their signals than low types (5% versus 17%), and anti-signal votes become more frequent empirically as the level p of partisanship increases.

Welfare. Figure 2 displays the realized average payoff in each independent group vis-à-vis the predicted payoff for the realized draws. Actual payoffs are lower than would have been obtained by following the equilibrium strategy, by 6% for majority rule and by 10% for PR. On average, this is only a welfare loss of 8% relative to equilibrium behavior; accordingly, the equilibrium prediction that welfare is higher under majority rule has clear empirical support (Mann-Whitney, $p < 0.05$ for all levels of partisanship), consistent with Hypothesis 5. Figure 2 also makes clear that welfare decreases with the share p of voters

²⁴This anomaly has been found repeatedly in experimental studies on information aggregation. For instance, see Guarnaschelli et al (2000), Bouton, Castanheira and Llorente-Saguer (2016) and Bouton, Llorente-Saguer and Malherbe (2017).

²⁵Existing 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).

who are partisan; this is intuitive, since partisans work against independent voters. On the other hand, deviations from equilibrium behavior also have less impact when the partisan share is high, so welfare loss relative to equilibrium decreases. This is most evident under PR with $p = 0\%$, where voters' failure to follow equilibrium prescriptions sacrifices a full 16% of potential welfare.

6 Conclusion

This paper has reported the results of the first laboratory experiment on common-value PR elections. Perhaps surprisingly, abstention is positive in both electoral systems, even though voting is costless and all voters have some information. Specifically, mildly informed voters do not allow their information to be aggregated in the voting outcome; instead, they prefer to leave the outcome in the hands of their peers, who they hope will be better informed. Notwithstanding the dissimilarity of the marginal and the pivotal voting inferences, abstention patterns are similar across electoral rules and, in treatments where predicted by the model, grant improved information aggregation and welfare in both systems. Finally, welfare is higher under majority rule.

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7 Appendices

Appendix A: Regression on Abstention

Variable	Coef.	Std. Err.	z	P>z	95% C.I.	
<i>High</i> × <i>M25</i>	0.021	0.012	1.81	0.071	[−0.002, 0.045]	
<i>High</i> × <i>M50</i>	0.019	0.006	3.26	0.001	[0.008, 0.031]	
<i>High</i> × <i>P0</i>	0.008	0.006	1.47	0.142	[−0.003, 0.020]	
<i>High</i> × <i>P25</i>	0.011	0.011	1.04	0.298	[−0.010, 0.032]	
<i>High</i> × <i>P50</i>	0.032	0.022	1.45	0.147	[−0.011, 0.075]	
<i>Low</i> × <i>M0</i>	0.420	0.062	6.77	0.000	[0.299, 0.542]	
<i>Low</i> × <i>M25</i>	0.293	0.038	7.63	0.000	[0.218, 0.368]	
<i>Low</i> × <i>M50</i>	0.284	0.050	5.69	0.000	[0.186, 0.382]	
<i>Low</i> × <i>P0</i>	0.361	0.093	3.89	0.000	[0.179, 0.543]	
<i>Low</i> × <i>P25</i>	0.359	0.040	9.08	0.000	[0.281, 0.436]	
<i>Low</i> × <i>P50</i>	0.272	0.061	4.5	0.000	[0.154, 0.391]	
Constant	0.003	0.006	0.54	0.588	[−0.009, 0.015]	
Observations	14,400		σ_u	.209	ρ	.313
Subjects	360		σ_e	.309		

Table 2: Random effects GLS regression of the probability of abstention on a constant and a number of dummies indicating the interaction between voter type, voting rule, and level of partisanship. High types in M0 are the reference group.

Appendix B: 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.

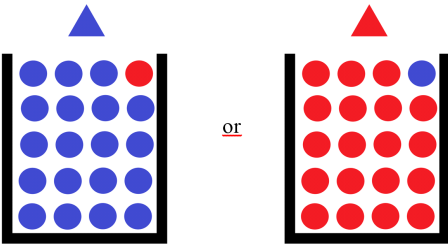
During the experiment all sums of money are listed in ECU (for Experimental Currency Unit). Your earnings during the experiment will be converted to euros at the end and paid to you in cash. The exchange rate is 40 ECU = 1€. The earnings will be added to a participation payment of 4€.

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.

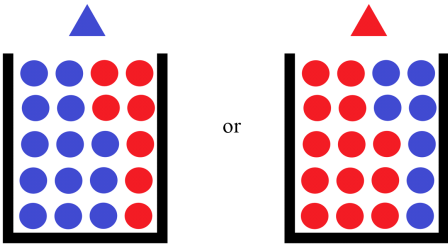
The Triangle Color. There is a triangle, and at the beginning of each round, the color of the triangle will be chosen randomly. With **50%** probability it will be **blue** ▲, and with **50%** probability it will be **red** ▲. You will not know the color of the triangle, but each member of your group 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 votes and 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						
		0	1	2	3	4	5	6
Number of votes for the color of the triangle	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.

Number of votes for the other color

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

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.

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.