Correlation neglect, voting behaviour and polarization

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Abstract: We analyse a voting model with voters who have correlation neglect, that is, they sometimes fail to appreciate that different sources of information might be correlated. While correlation neglect has the effect of polarising opinions, we show that this doesn't translate directly to inefficient outcomes. Indeed we show that compared with a rational electorate, when the distribution of preferences in society is heterogeneous and sufficiently balanced, a society composed of voters with correlation neglect may aggregate information in a more efficient way. Moreover, we show that the polarisation in opinions does not necessarily translate into policy polarisation.

1 Introduction

The political ignorance of voters during election is well established in the political science literature.[1] While there is wide agreement about voter ignorance, there is an on-going debate about its implications to political outcomes. Some have suggested that voters use cues and information short-cuts to arrive at informed voting decisions (Lupia 1994). Others take a more grim view, showing how even large electorates take decisions that are far from an informed ideal (see Bartels 1996, Druckman 2012 and Taber et al 2006).

To understand such voting behaviour the literature has looked at the way voters filter sequences of informative signals. Motivated by theories in social psychology[2], much attention has been devoted to how individuals with limited attention process large amounts of information.[3] More recently the literature has focused on correlation neglect (De Marzo et al 2003, Ortoleva and Snowberg 2012 and Glaeser and Sunstein 2009). This cognitive bias implies that individuals under-appreciate the level of correlation among the different sources of information they are exposed to.[4]

[1] On this Bartels (1996) writes: "One of the most striking contributions to the political science of half a century of survey research has been to document how poorly ordinary citizens approximate a classical ideal of informed democratic citizenship."

[2] Such as Lichtenstein and Strul (1987) and Hastie and Park (1986).

[3] Among others these include issue order effects, confirmation bias and the special attention voters devote to negative information. See Taber and Lodge (2006), Meffert et al (2006), Redlawsk (2002), Lodge et al (1995) and McGraw et al (1990). The biases in information processing that are due to limited attention or memory are also analyzed in a recent theoretical literature in Economics, see Wilson (2002) and Compte and Postlewaite (2012).

[4] In the context of financial markets, Eyster and Weizsacker (2012) conduct an experiment to show that

In this paper we focus on the positive and normative implications of correlation neglect on political outcomes in the context of electoral competition. Around election time, voters are bombarded with many and different pieces of information. A typical assumption in the literature is that voters receive independent information (or can identify the independent content of each signal). In contrast, we entertain the assumption that different outlets might provide correlated or even repeated information. Voters with correlation neglect will then have trouble identifying the independent content of each signal.[5] We characterise how this bias affects the level of polarisation in opinions and policy outcomes. On the normative side we compare the information aggregation properties of this model to one in which voters are rational.

Specifically, we analyse a voting model in which a population of voters with heterogeneous ideal policies have to choose between two policies, one on the right and one on the left. From the point of view of the median voter, the policy on the right (left) is more suitable for a high (low) state of the world. Each voter receives two (potentially correlated) signals about the state of the world. Given their information, voters make their voting decisions. The aggregate vote share along with an aggregate shock determine the political outcome. Thus, the outcome is monotone in the vote shares.

In our first result, we show that correlation neglect can be beneficial in the context of voting. We show that the vote share for the correct outcome (from the point of view of the median voter) can be larger when voters have correlation neglect. Intuitively, correlation neglect magnifies the effect of information on individuals' behaviour. Individuals who might otherwise stick with their ideological bias, might be swayed to change their votes if they believe that the information is sufficiently strong in that direction. Therefore, in the aggregate, when society is sufficiently balanced between left and right, voting is more informative. In other words, even if voters with correlation neglect do not behave optimally from an individual point of view, they do so as a collective, and thus may gain higher average welfare. We show that this result also holds when we endogenise both the level of correlation in information sources and platform choice.

In our second result we show that, counterintutively, correlation neglect may imply lower polarisation of politicians' platforms. We endogenise the choice of platforms and show that compared with a rational electorate, polarisation can both increase or decrease when voters have correlation neglect. On the one hand, correlation neglect leads to polarisation

individuals neglect correlation when choosing a portfolio (see also Kallir and Sonsino 2009 and Enke and Zimmermann 2013). Such a cognitive bias will clearly have negative implications for individual decision making in e.g., portfolio choice, as is shown in Eyster and Weizsacker (2012).

[5] In Britain, for example, all the newspapers owned by Rupert Murdoch endorsed Tony Blair in 1997 and David Cameroon in 2010. Voters who are not aware of the ownership structure in the media market will overlook such (potential) correlation and treat each endorsement as an independent signal.

of opinions in the electorate or more specifically to higher variance in the beliefs of voters. This tempts ideological candidates to move away from the middle. On the other hand, voters' sensitivity to candidates' deviations might differ depending on how they process information. We show that the sensitivity of voters with correlation neglect might be larger than that of rational voters. As a result, candidates facing rational voters might be more tempted to diverge towards their ideal policies.

We next endogenise the information sources that voters are exposed to by assuming that they can, at a cost, make their information sources more independent.[6] We show that investments in the quality of information are $\mathcal{M}$-shaped in ideological bias. In particular, moderates and extremists invest relatively less in information quality than intermediate voters on both sides. This implies that the degree of polarization in one's belief is not monotone in her ideology. For example, for a behavioural voter, starting from a moderate position, her beliefs become first less volatile with ideology and then more volatile.

This paper is related to a recent literature on correlation neglect. In Ortoleva and Snowberg (2012) individuals receive a stream of signals, some correlated. Their model implies that the higher is the level of correlation neglect of an individual, the more extreme his beliefs will be. De Marzo, Vayanos and Zwiebel (2003) analyse a model of multiple rounds of communication (in a network) when players have correlation neglect. They show that this implies that views will become concentrated on a one-dimensional conflict. While both these papers focus on individual beliefs, we instead focus on embedding correlation neglect in a voting model and thus consider collective decisions.[7]

Glaeser and Sunstein (2009) model a similar behaviour in a group setup, where agents ignore the correlation between theirs' and others' information. They show that homogenous groups may perform worse than an individual decision maker, and that greater polarization and overconfidence arises in groups.[8] Our results are complementary to theirs as we show that heterogeneous groups with correlation neglect may perform better than a rational group of voters.

Our analysis also contributes to the literature on group decision making with Bayesian failures or cognitive biases. For example Benabou (2009) and Bolton, Brunermeir and Veldkamp (2010), show the benefits of overconfidence. We also show that a behavioural

[6] There is a large literature in political science focusing on the degree of political sophistication of different voters (see Bartels 1996, Weisberg and Nawara 2010). While some find support for why extreme voters are more politically savvy (Sidanius and Lau 1989) others show that it is the ideological centrists who are the most sophisticated in their voting (Tomz and Van Houweling 2008).

[7] Blomberg and Harrington (2000) show that rigidity of beliefs is associated with extremism in the context of a fully Bayesian model as individuals who do not converge to the moderate opinions with a sequence of public signals must have had strong initial opinions. They also conduct empirical analysis to show that voting behaviour of senate members with extreme views does not change much over time.

[8] For empirical evidence see Brown (1986) and Schkade, Sunstein and Kahneman (2000).

bias can be beneficial; our mechanism is different though as it relies on a heterogeneous but sufficiently balanced group of agents.

There are several papers that analyse the costs and benefits of platform polarization. Martinelli (2006) analyses an election with two fixed alternatives in which voters can acquire some costly information about the alternatives. He shows that for some cost functions, outcomes may be efficient even for arbitrarily large numbers of voters. Degan (2006) finds that moderate citizens are the most likely to both acquire political information and abstain and that polarization increases information acquisition as well as abstention. Bernhardt et al (2009) show that voters prefer some polarization to none even when they have no additional information. Several papers show how platform polarization can arise when the public is more informed or has more polarized beliefs, see for example Gul and Pesendorfer (2012). We show that the opposite can also arise; that is, even when voters have more polarized beliefs, platform polarization might be lower.

The remainder of the paper is as follows. In the next Section we present the model. In Section 3 we analyse voting decisions and welfare. Section 4 endogenises the platform choice of politicians and the levels of the correlation of information as a function of ideological bias. We conclude with some discussion of our results and a comparison to an alternative behavioural model (confirmation bias), in Section 5.

2 The Model

In our main model we focus on the implications of voters' correlation neglect on information aggregation and polarisation. Initially, we focus on information aggregation and so assume that platforms are fixed. We relax this assumption in Section 4, where we allow for endogenous platforms.

Assume then that there are two platforms, $x > 0$ and $-x$, with $x \leq 1$. There is a continuum of voters. Each voter i has an ideal policy v_i distributed according to a distribution function $F(v_i)$ with density $f(v_i)$ symmetrically around the median 0 on $[-1, 1]$. The utility of voters, specified below, will depend on the chosen platform as well as on the realisation of a state of the world, $\omega \in \{-1, 1\}$. The prior is that each state occurs with equal probability.

The information structure: We assume that each voter i receives a private signal $s_i^0 \in \{-1, 1\}$ with accuracy $q \geq \frac{1}{2}$, i.e., $\Pr(s_i^0 = \omega|\omega) = q$. We assume that voters are exposed to more information, that is, each receives an additional private signal s_i. Generally, information sources might be correlated with each other. For simplicity, we assume that with probability ρ_i the signal s_i is fully correlated with s_i^0, and with probability $1 - \rho_i$, s_i

will be a new independent signal $s_i^1 \in \{-1, 1\}$ with accuracy q.[9]

We allow different voters to have different levels of correlation in their information; for example this might depend on how much they can gain from processing information. We thus allow ρ_i to depend on v_i. Specifically, assume that the distribution of $\rho_i = \rho(v_i)$ is exogenously given and symmetric around $v_i = 0$. In Section 4 we will endogenise such distribution by allowing voters to choose the level of correlation of their information sources at a cost.

In what follows we compare voters with correlation neglect to rational voters. We assume that a voter with correlation neglect does not understand that the signals might be repeated. Such a voter always believes that the second signal s_i is the independent signal s_i^1. A rational voter on the other hand, fully recognizes when the signal is repeated and when it is genuinely independent. Thus, ex ante, with probability ρ_i she will ignore s_i, and with probability $1 - \rho_i$ she will update her beliefs on the state of the world.[10] For comparison, we assume that rational and behavioural voters have the same distribution of correlation in information. Our results are robust to alternative specifications in which these levels differ.

Remark 1: Polarization of beliefs. In the above model the beliefs of all voters, rational or not, will have the same mean. The variance however will be different and beliefs will differ between rational voters and those with correlation neglect in the second order stochastic dominance sense. Specifically, our model implies that the beliefs of a rational voter i with any v_i have less variance compared with a voter j with correlation neglect and any v_j. To see why, note that a voter with correlation neglect faces a lottery between two independent signals or two fully correlated signals (where the latter induces higher variance), while a rational voter faces a lottery between two independent signals and one signal (where the latter induces lower variance). This implies that the beliefs of the rational voter are strictly less volatile, no matter what is her ideology.

The political environment: Upon the realization of the signals s_i^0 and s_i, and given their posterior beliefs, voters vote either for platform x or for $-x$.[11] Let V_x denote the vote share for platform x. In the spirit of probabilistic voting, we assume that platform x wins if $V_x > V_{-x} + \zeta$, where ζ is a shock to the vote share, distributed uniformly on $[-1, 1]$. It will be simplest to maintain $V_x = 1 - V_{-x}$ and thus ζ can be interpreted as

[9] The assumption that we consider only two pieces of information is not important. Also, the assumption that signals are either fully correlated or fully independent is for simplicity.

[10] The assumption that a rational voter fully recognizes when the signal is repeated is made for simplicity; we can assume instead that he uses the probability ρ_i in his Bayesian updating.

[11] We assume that all voters vote. In Section 5 we discuss the robustness of the results to endogenous turnout.

the share of votes that is transferred from x to $-x$. Thus, conditional on a vote share V_x, platform x wins with $\Pr(\zeta < 2V_x - 1) = V_x$. The exact distribution of the noise is not important for our main results.

Denote by y the outcome of the election and let $\hat{y}$ denote the policy that the voter votes for. We assume that a voter maximizes the following utility function:

$$\alpha U(v_i, \omega, y) + U(v_i, \omega, \hat{y})$$

where

$$U(v_i, \omega, z) = -(\omega + v_i - z)^2.$$

The first element implies that voters derive utility from the collective outcome being correct, and the second element implies that they also derive utility from their individual vote being correct. This second element will induce voters to vote sincerely which is now a common simplification in the voting literature; for some recent examples see Gul and Pesendorfer (2012) or Chan and Suen (2008). As the focus of this paper is on voters who are unable to process information correctly, we find it more suitable to consider sincere voting and thus use the utility function above; we show in Section 5 that our results also hold when one assumes that voting is strategic.

3 Voting with correlation neglect

We say that the political outcome y is the correct policy when it accords with the policy that the median voter will choose when he knows the state of the world. In this Section we derive our first main result, showing that a society composed of voters with correlation neglect will choose the correct policy with a higher probability.

As a first step, Lemma 1 characterizes how voters vote when they receive one or two signals. Remember that voters with correlation neglect will always believe that they have two independent signals, while rational voters will sometimes have just one signal. Note that by the continuum of citizens, an individual's probability of being pivotal is zero. Hence, they only consider the second element of their utility function when deciding how to vote, which implies that they vote sincerely, i.e., for x over $-x$ iff $EU(v_i, \omega, x) \geq EU(v_i, \omega, -x)$. Let

$$v_1 \equiv 2q - 1 < v_2 \equiv \frac{2q-1}{q^2 + (1-q)^2}.$$

Lemma 1: *Consider all types with $v_i \geq 0$ (all types with $v_i \leq 0$ will have behaviours that are a mirror image). (i) A voter with $v_i < v_1$ who observes only one signal follows it, i.e., votes x(-x) if the signal is 1(-1). A voter with $v_i > v_1$ who observes one signal only votes for x. (ii) A voter with $v_i < v_2$ who believes he has two independent signals votes for x unless the two signals are -1. A voter with $v_i > v_2$ always votes for x.*

To see how the voting behaviour translates into vote share, suppose now that the state of the world is 1. With probability $1-\rho$, a behavioural voter with an ideological parameter v in (v_1, v_2) votes for x as long as his two independent signals are not both -1, which happens with probability $(1-(1-q)^2)$. With probability ρ, this voter votes for x when $s_0 = 1$, which happens with probability q (as otherwise if the signal is -1 it is repeated and this voter is convinced to vote for $-x$). A rational voter with the same ideology votes in the same way with probability $1-\rho$, but with probability ρ he votes for x with probability 1 as he has only one signal which is not sufficient to convince him to vote against his ideology. This along with the assumption of the continuum of voters allows us to compute the vote share for each platform. We then have our first main result:

Proposition 1: *The vote share for the correct policy is higher in an electorate of voters with correlation neglect compared with an electorate of rational voters.*

Figure 1 shows the probability that different voters cast the correct vote in state $\omega = 1$, if $s_i = s_i^0$ (i.e., conditional on the ρ event), as derived from Lemma 1.

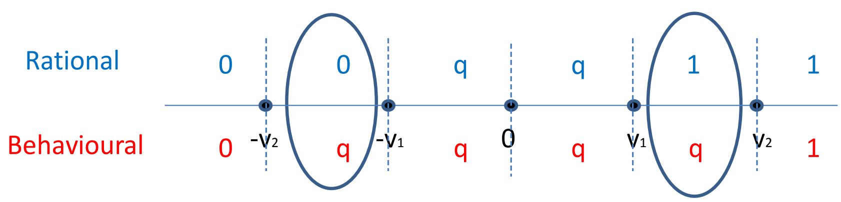

Figure 1: The probability that different voters cast the correct vote in state $\omega = 1$, conditional on the ρ event.

It is easy to see from Figure 1 how this result arises. First, moderate voters and extreme voters vote in the same way whether they have correlation neglect or not. Extreme voters (above v_2 or below $-v_2$) always vote with their ideology, and moderate voters in $[-v_1, v_1]$ vote on the basis of their first signal both when they are rational, and when they have correlation neglect. When they are rational they are aware that they are voting on the basis of the first signal and so vote informatively, whereas when they have correlation neglect they do so as it is repeated.

We therefore focus on the intermediate voters (circled in the figure). Consider a voter $v_i \in [v_1, v_2]$ and his mirror image $-v_i$. Rational voters realize that there is no information content in their new signal and thus these voters vote with their ideology. This implies that only a right-wing voter votes for x, and so in the ρ event, the aggregate probability of v_i and $-v_i$ together voting for x is $f(v_i)$. For voters with correlation neglect this is different. In the event of correlated information, with probability q, both right-wing and left-wing voters vote for x, as the signal is repeated and can convince those on the opposite side to vote for the right option. This implies that the expected aggregate vote for both

v_i and $-v_i$, conditional on the second signal being a repeat of the first, is $2f(v_i)q > f(v_i)$. More generally, in societies which are sufficiently balanced between right and left wing voters, the result would hold.[12]

Given Proposition 1, we can compare the utilitarian welfare of a rational society vis a vis a behavioural society (recall that α is the weight on the utility from the correct election outcome in a voter's utility function):

Proposition 2: *There exists $\bar{\alpha}$ such that for all $\alpha \geq \bar{\alpha}$ an electorate of voters with correlation neglect has a higher ex ante average utility. Moreover, if the level of correlation in society increases (i.e., $\rho(v)$ increases for all v), then $\bar{\alpha}$ is smaller.*

The intuition is simple: when α is sufficiently large, what matters is the outcome of the aggregate vote and not whether individual voters have voted correctly. While each behavioural voter is not acting optimally, at the aggregate, and from the point of view of the median voter, the voters with correlation neglect are better at achieving the correct outcome in a sufficiently balanced society.[13] As the difference in behaviour arises in the events in which information is indeed correlated, then if such correlation increases, the difference in vote share becomes larger. The higher welfare result for behavioural voters is then supported for more parameters.

Note that our results also apply to mixed electorates; an electorate with a higher share of voters with correlation neglect will do better at information aggregation. Moreover, the results above are robust to some asymmetry in the preferences; as behavioural voters vote more informatively while rational voters vote more ideologically, then as long as society is not too ideological in one direction, our result holds and there will be parameters for which the welfare of behavioural voters is larger.

Another implication of Proposition 1 is that ex ante, behavioural voters might prefer a higher level of polarization (i.e., a higher x) compared with rational voters. To see why, note that when voters are fully informed, they would rather have full polarization all the way to $x = 1$. When voters have no information, they would not want to take the risk involved in large polarisation. Thus the more information they have the more polarization is attractive. We summarize this below:

Proposition 3: *There exists a large enough α', such that for all $\alpha \geq \alpha'$, the optimal level of polarization x is larger for an electorate of voters with correlation neglect compared with an electorate of rational voters.*

[12] Recall that $f(v_i) = f(-v_i)$. This comparison holds more generally when there is sufficient symmetry, i.e., as long as $\frac{1-q}{q} < \frac{f(v)}{f(-v)} < \frac{q}{1-q}$.

[13] When α is small on the other hand, what is important for voters is that each behaves optimally. Trivially, rational voters are better at doing that.

There is an emerging consensus in the literature that polarization between the two major parties in the US is on the rise (see Poole and Rosenthal, 1984, 1985, 2000). The result of Proposition 3 indicates that greater political polarization, if voters have correlation neglect, is not necessarily welfare-reducing.

A relevant question therefore is whether correlation neglect in itself will induce greater levels of polarization. We now proceed to analyse the effect of correlation neglect on the polarisation of platforms. To this end, we extend the model to allow ideological politicians to choose their platforms optimally.

4 Polarization and correlation neglect

In this Section we analyse the effect of correlation neglect on polarization of policies. In our model behavioural voters have more volatile beliefs; greater polarization in beliefs, compared with rational voters, might imply that ideological politicians will choose more polarized platforms. We show below that this is not necessarily the case.

In Section 4.1, we first extend the model to allow for strategic ideological politicians, and show how the distribution of information correlation ($\rho(v)$) affects the levels of polarization. In Section 4.2, we endogenise this distribution by allowing voters to invest in independent information and show that this implies -counter-intuitively- that there is less polarization in behavioural societies. Finally, we extend the political competition model in Section 4.3 and show that more competitive electoral systems might induce the opposite effect where more polarization arises in behavioural societies.

4.1 Polarisation and correlation of information

In this Section we introduce two strategic politicians who will choose their platforms endogenously. We unravel a new effect by showing that the rational and behavioural voters differ in their sensitivity to politicians' deviations to more extreme policies. This, as we show, implies that whether behavioural societies induce more polarization or not depends on the distribution of correlation of information in society ($\rho(v)$).

Consider then two politicians r and l who choose platforms $x_r > 0$ and $x_l < 0$ to compete in the election. The candidates choose their policies prior to learning any new information about the state of the world. We assume candidates have single-peaked policy preferences, given by a concave utility function, $U_i(y)$ for $i \in \{r, l\}$, which does not depend on ω (for simplicity). Let the ideal policy of r (l) be at 1 (-1). To simplify, let us assume that voters are distributed uniformly on $[-1, 1]$.

Let $\Delta_{U_r}(x_r, x_l) = U_r(x_r) - U_r(x_l)$. Let $V^J_{x_r}(\omega)$ be the vote share for candidate R in state ω when voters' type is given by $J \in \{R, B\}$, i.e., rational or behavioural respectively. The expected utility of candidate r is therefore:

$$E\hat{U}_r^J(x_l, x_r) = \Pr{}^J(r \text{ elected})\Delta_{U_r}(x_r, x_l) + U_r(x_l)$$

where

$$\Pr{}^J(r \text{ elected}) = \frac{1}{2}V_{x_r}^J(1) + \frac{1}{2}V_{x_r}^J(-1)$$

Given x_l, politician r chooses x_r and the first order condition is:

$$\frac{\partial E\hat{U}_r^J(x_l, x_r)}{\partial x_r} = \frac{\partial \Pr{}^J(r \text{ elected})}{\partial x_r}\Delta_{U_r}(x_r, x_l) + \frac{\partial U_r(x_r)}{\partial x_r}\Pr{}^J(r \text{ elected})$$

Evaluated at a symmetric equilibrium this becomes

$$\frac{\partial E\hat{U}_r^J(x_l, x_r)}{\partial x_r} = \frac{\partial \Pr{}^J(r \text{ elected})}{\partial x_r}\Delta_{U_r}(x_r, x_l) + \frac{\partial U_r(x_r)}{\partial x_r}\frac{1}{2} = 0$$

where

$$\frac{\partial \Pr{}^J(r \text{ elected})}{\partial x_r} = \frac{1}{2}\frac{\partial V_{x_r}^J(1)}{\partial x_r} + \frac{1}{2}\frac{\partial V_{x_r}^J(-1)}{\partial x_r} < 0 \tag{1}$$

As is standard in such models, when a politician considers deviating, a trade-off arises between her chances of being elected and her utility conditional on being elected. If politician r moves her platform further to the right, her utility will be higher conditional on being elected, while her probability of being elected is reduced. The equilibrium balances these two incentives.

When comparing rational and behavioural voters, it is only the effect on the probability of winning which differs between the two. If second order conditions hold, then a larger sensitivity of the probability of winning to a deviation will result in lower polarization. We now compute how this sensitivity, formalised in (1), differs between the two societies.

As can be seen from (1), the reduction in the probability arises as the vote share decreases ($\frac{\partial V_{x_r}^J(\omega)}{\partial x_r}$). This arises as the cutoffs specified in Lemma 1 all shift to the right as voters are less inclined to vote for the right-wing politician (the shift does not depend on the state of the world). We characterize this effect in the following Lemma:

Lemma 2: $\frac{\partial V_{x_r}^B(1)}{\partial x_r}, \frac{\partial V_{x_r}^R(1)}{\partial x_r}, \frac{\partial V_{x_r}^B(-1)}{\partial x_r}, \frac{\partial V_{x_r}^R(-1)}{\partial x_r} \leq 0$ and

$$\frac{\partial V_{x_r}^B(1)}{\partial x_r} - \frac{\partial V_{x_r}^R(1)}{\partial x_r} = \frac{1}{4}(\rho(v_1) - \rho(v_2)) = \frac{\partial V_{x_r}^B(-1)}{\partial x_r} - \frac{\partial V_{x_r}^R(-1)}{\partial x_r}$$

According to the Lemma, following a deviation to the right, the vote share for x_r will be reduced less in a rational society compared with a behavioural society iff $\rho(v_1) < \rho(v_2)$

(recall that $\frac{\partial V^J_{x_r}(\omega)}{\partial x_r} < 0$). To see why, consider only the event where the signal is repeated, and only the intermediate intervals (where behavioural and rational voters' behaviours differ). Note that following a deviation, all cutoffs move to the right, which implies a replacement of a voter with a level of correlation $\rho(v_1)$ with one with a level of correlation $\rho(v_2)$ in $[v_1, v_2]$ and vice verse in $[-v_2, -v_1]$. For the behavioural voters this change -on both the right and the left- is neutral, as agents in these two intervals behave in the same manner when the signal is repeated and hence right-wing and left-wing agents "cancel out" one another. For the rational voters this change is neutral in the left-wing interval as voters there do not vote for the right (when the signal is repeated) but not in the right-wing interval where voters vote with probability one for politician r. Thus for the rational voters the relative change in vote share is of order $\rho(v_2) - \rho(v_1)$.

When second order conditions hold,[14] we can use the above to deduce:

Proposition 4:

(i) If $\rho(v_1) > \rho(v_2)$ then for any equilibrium in the model with rational voters, there is an equilibrium with more polarization in the model with behavioural voters. (ii) If $\rho(v_1) < \rho(v_2)$, then for any equilibrium in the model with rational voters, there is an equilibrium with more polarization in the model with behavioural voters.

Thus, polarization of beliefs induced by correlation neglect does not necessarily induce polarization of platforms by candidates. In terms of welfare, note that it is easy to find environments in which the level of polarization is very similar in both models. This implies that the result in Proposition 2 is robust to the endogenous choice of policies. This can arise for example when politicians' utilities are very steep around their ideal policies or when $\rho(v_1) \approx \rho(v_2)$. Moreover, Proposition 3 implies that even if policies are more polarized, welfare in the behavioural society can be higher as voters behave as if they are more informed. In other words, they can enjoy policies that target better the state while maintaining relatively low ex ante variance.

In the above analysis we have fixed the levels of correlation in the sources of information that voters are exposed to. In the next Section we analyse what happens when voters can invest to decrease the levels of correlation between their information sources.

4.2 Endogenous levels of correlation

In this Section we allow voters to invest in order to increase the degree of independence between their information sources. One way to interpret this is an investment in the quality of information, e.g., buying a quality magazine or newspaper rather than the free papers distributed on mass transport systems in big cities, which merely repeat yesterday's

[14] This arises, for example, when the politicians' utilities are sufficiently concave.

news (see Section 5.1). We find that investment in information would be a non-monotone function of the level of ideology v, and that $\rho(v_1) < \rho(v_2)$. Thus, given Proposition 4, behavioural societies will induce less polarization when voters can invest in information.

Specifically, assume that a voter i can decrease the level of correlation ρ_i by investing according to the cost function $c(1-\rho_i)$, with $c', c'' > 0$. If a voter does not invest, then $\rho_i = 1$. For simplicity, we assume that a voter with correlation neglect is not aware that when she will observe the signal, she will misinterpret its source (our results also hold when voters understand their predicament, see Remark 3). We assume that individuals choose their investment prior to learning s_i^0; they therefore make their investment decision conditional on v_i, x, and q. Our results easily extend to consider investment in information after receiving the signal s_i^0.

We start by considering the model with fixed platforms x and $-x$. Given their expected voting behaviour, yielding a random policy choice $\hat{y}(\rho_i)$, voters choose ρ_i to maximize $EU(v_i, \omega, \hat{y}(\rho_i)) - c(1-\rho_i)$. Moreover, as behavioural voters are not aware of their correlation neglect, they will choose exactly the same level of information investment as chosen by rational voters. We therefore have the following:

Lemma 3: *Consider all types with $v_i \geq 0$ (types with $v_i < 0$ are characterized symmetrically): For both rational and behavioural individuals, $\rho(0) = 1, \rho'(v_i) < 0$ for $v_i \in [0, v_1]$, $\rho'(v_i) > 0$ for $v_i \in [v_1, v_2]$, and $\rho(v_i) = 1$ for all $v_i \geq v_2$. Also, $\rho(v_i)$ decreases in x.*

Consider first moderate voters (below v_1). Getting more information implies that they can vote more often for the platform they initially prefer, on the right; with one signal they vote to the left whenever this signal indicates that the state is -1, but with two signals they do so only when the two signals are -1. In this region therefore, the stronger is the ideology the more investing in information is favourable.

Intermediate voters on the other hand will vote to the right in the absence of additional information and thus investment in information increases their probability of actually voting to the left. The more ideological they are, the less attractive this is, and hence investment in information is decreasing in their type in this region. Finally, as the second signal does not affect the voting decisions of the most extreme voters, they do not invest at all in quality of information. Figure 2 below graphs the $\mathcal{M}$-shaped independent information level $1-\rho_i$ given the ideology v_i :

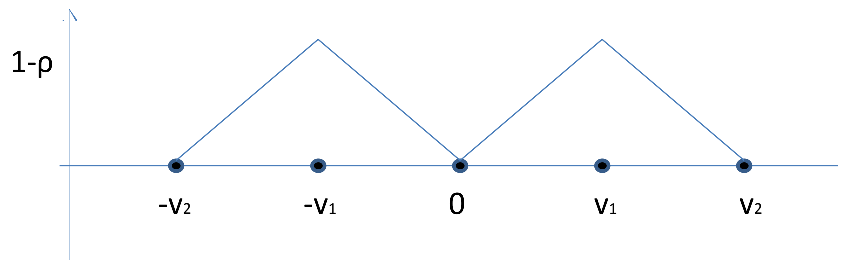

Figure 2: $1-\rho_i$ as a function of the ideology v_i.

Note that investing more in independent information makes the beliefs of a rational voter more volatile, and the beliefs of a voter with correlation neglect less volatile. When a voter with correlation neglect invests in more information his beliefs will be less extreme as he will draw a second independent signal instead of a repetition of the same signal. When a rational voter invests in information he will get an additional signal with a higher probability compared with just one signal, which increases the volatility of beliefs. This, together with Lemma 3, implies that the beliefs of a behavioural voter, starting from a moderate position, become first less volatile with ideology and then more volatile. On the other hand, the beliefs of a rational voter become first more volatile with ideology and then less volatile.

Remark 2: Beliefs vs ideology: In Ortoleva and Snowberg (2012) agents are more extreme in their beliefs when they have correlation neglect but in our model that will depend on their ideology and can be non-monotone in ideology. Specifically, the observation that extreme voters have strong beliefs in line with their ideology will be correct in our model only for behavioural voters (and not rational ones). Also in our model, right-wing and left-wing agents have the same beliefs on average, but vote differently due to their different ideology. Empirically it is naturally hard to disentangle if individuals vote because of strong beliefs or strong ideology.[15]

All our results hold for this extension of the model. Specifically, the distribution of correlation of information is symmetric in ideology which implies that Propositions 1 and 2 hold. Example 1 below provides a numerical calculation of voting and welfare for the two societies when information is endogenous, illustrating that the critical value of $\bar{\alpha}$ (above which welfare in a behavioural society is higher) can be quite small:

Example 1: *Suppose that* $x = 0.5$, $q = 0.75$, $c(1-\rho) = 2(1-\rho)^2$, *and that voters are distributed uniformly on [-1,1]. The vote share for the correct outcome for the behavioural*

[15] Blomberg and Harrington (2000) show that U.S. Senate members with extremist voting behaviour rarely change their votes; in our model extreme voters indeed vote in the same way disregarding the information they have but this reflects not their extreme beliefs but their extreme ideology.

and for the rational electorate is ≈ 0.7 *and* ≈ 0.6285 *respectively. The cost of information is the same in both electorates, and as a result for all* $\alpha > 0.52$, *the welfare of a behavioural electorate is higher.*

We now consider endogenous platforms. One difference that arises when the quality of information is endogenous, is that individuals will change their investments when candidates change their platforms. In line with Lemma 3, when there is more polarization, voters invest more as their decision becomes more important. This implies that when a candidate deviates to a more extreme platform, voting becomes more informative. As we show in the proof however, this effect washes out as ex-ante, it equally pulls the vote shares in opposing directions for the different states of the world. In other words, the additional votes that a right-wing candidate receives in state $\omega = 1$ (as voters are more informed) equals ex ante the reduction in votes that she receives in $\omega = -1$. This implies that the analysis follows as above.

Moreover, from Lemma 3, we know that $\rho(v_1) < \rho(v_2) = 1$. This arises as the type in v_2 finds information of very little use (as above v_2 all voters vote right for all types of information), whereas a moderate agent in v_1 changes his behaviour with information and thus finds it useful to invest in quality of information. Therefore, using similar arguments as in Proposition 4 we can show,

Proposition 5: *With endogenous information investment, for any equilibrium in the model with rational voters, there is an equilibrium with less polarization in the model with behavioural voters.*

From a welfare point of view, the effect of more or less polarization is not obvious in our model. A more informed vote might induce more polarization, while more polarization will induce more investment in information (i.e., lower $\rho(v)$ for all v), as shown in Lemma 3. If voters would be fully informed, polarization increases welfare as platforms can target the state better, but if voters are not sufficiently informed then greater polarization is harmful given their risk aversion.

We revisit Example 1 above. We show that when we allow for endogenous platforms, rational voters, in line with Proposition 5, induce more polarization. While they also acquire more information, this information is not sufficient to overturn our result in Proposition 2:

Example 1 with endogenous platforms: *Consider again Example 1 which has* $q = 0.75$, $c(1-\rho) = 2(1-\rho)^2$. *Assume that the politicians have quadratic loss utilities with ideal policies at* 1 *for* r *and* -1 *for* l, *for any* ω. *The unique equilibrium for the case of behavioural voters has* $x_r = -x_l = 0.5$ *with the correct vote share at 0.7. For* *rational voters, $x_r = -x_l = 0.5265$ in the unique equilibrium. Rational voters invest more in information but the correct vote share is only slightly higher at 0.6287. Thus for all $\alpha > 0.54$, the welfare of a behavioural electorate is higher.*

Remark 3: Sophisticated-behavioural voters: Suppose that voters that exhibit correlation neglect are aware of this predicament when choosing to invest in their future information sources. It is then easy to show that for intermediate level of ideology, the more ideological the voter is, the more he invests in information. For rational voters (or those who are unaware of their correlation neglect), a stronger ideology in the region $[v_1, v_2]$ implies a lower value of information as information would only convince them to vote against their initial bias. However, for sophisticated voters who are aware of their correlation neglect, a stronger ideology implies a stronger need for protection from being fooled.[16] This also implies that all such voters invest more (weakly) in information compared with rational voters, and that all the other welfare and political polarization results comparing such a society to a rational society follow as stated in the previous Sections.

4.3 Polarization and the competitiveness of the political system

We have shown in Propositions 4 and 5 that greater volatility of beliefs does not necessarily imply greater polarization of platforms and that in fact, when we allow for endogenous investment in independent information, it actually implies lower polarization. Specifically, the effect we had unravelled is that behavioural voters may react more to a deviation to more extreme policies, deterring politicians from polarization.

To complete the picture, we now vary the competitiveness of the political system as embodied by our probabilistic voting function. We show that when the competitiveness of the political system is sufficiently low, behavioural electorates induce less policy polarization but otherwise it might go either way.

Suppose that society is composed of N (odd) districts, where each district has a continuum of voters constituting a replica of the voting population in our basic model. In each district i a candidate for the right-wing party proposing platform x wins if $V_x^i > V_{-x}^i + \zeta^i$, where ζ^i is an idiosyncratic district-noise distributed uniformly on [-1,1]. Platform x (or the right-wing party) wins the overall election if it wins a majority of the districts. Note that given the continuum of voters, the expected vote share for platform x in each district would be identical to V_x as computed in our model in Proposition 1.

The next Lemma derives the probability of platform x being elected as a function of this vote share V_x :

Lemma 4: *In an N-district society, the probability that platform x wins as a function*

[16] Proposition A1 in the appendix proves this.

of some $V_x \in [0.5, 1]$ *is:*

$$G^N(V_x) = \sum_{i=\frac{N+1}{2}}^{N} \binom{N}{i} (V_x)^i (1 - V_x)^{N-i}$$

which is concave on $V_x \in [0.5, 1]$*. Moreover, the larger is* N*, the more concave is* $G^N(V_x)$ *and when* $N \to \infty$*,* $G^N(V_x) \to 1$ *for* $V_x > 0.5$*.*

When $N = 1$, as in our basic model, the noise ζ looms large. Achieving a vote share greater than a half only guarantees a probability of being elected set at V_x. When there are many districts though, the idiosyncratic district level shocks cancel out, and for large N, this implies that a vote share larger than a half guarantees winning with probability almost one. A political system with a larger N can be interpreted therefore as more competitive.

All our results in Section 3 hold for this extension and we now turn to the analysis of endogenous platforms. Specifically, the derivative specified in (1) now changes to be:

$$\begin{aligned} &\frac{\partial \Pr^J(r \text{ elected})}{\partial x_r} \\ &= \frac{1}{2} \frac{\partial G^N(V^J_{x_r}(1))}{\partial V^J_{x_r}(1)} \frac{\partial V^J_{x_r}(1)}{\partial x_r} + \frac{1}{2} \frac{\partial G^N(V^J_{x_r}(-1))}{\partial V^J_{x_r}(-1)} \frac{\partial V^J_{x_r}(-1)}{\partial x_r} \\ &= \frac{1}{2} \frac{\partial G^N(V^J_{x_r}(1))}{\partial V^J_{x_r}(1)} \left(\frac{\partial V^J_{x_r}(1)}{\partial x_r} + \frac{\partial V^J_{x_r}(-1)}{\partial x_r} \right) \end{aligned} \tag{2}$$

where the second equality follows from the symmetry of the model, as $\frac{\partial G^N(V^J_{x_r}(1))}{\partial V^J_{x_r}(1)} = \frac{\partial G^N(V^J_{x_r}(-1))}{\partial V^J_{x_r}(-1)}$. Note that $\frac{\partial V^J_{x_r}(1)}{\partial x_r}$, $\frac{\partial V^J_{x_r}(-1)}{\partial x_r}$ are as characterized in Lemma 2, and that $\frac{\partial G^N(V^J_{x_r}(1))}{\partial V^J_{x_r}(1)} = 1$ for $N = 1$ as in our model, but by the concavity established in Lemma 4, we have that:

$$\frac{\partial G^N(V^R_{x_r}(1))}{\partial V^R_{x_r}(1)} > \frac{\partial G^N(V^B_{x_r}(1))}{\partial V^B_{x_r}(1)}$$

which follows from Proposition 1 as $V^R_{x_r}(1) < V^B_{x_r}(1)$. This implies that the probability of being elected for a politician who deviates will be reduced more in a rational society (everything else equal). In other words, this effect is driven by the result that behavioural voters are more likely to choose the right platform in the right state of the world; a deviation by the politician will not damage much her chances of winning in the correct state of the world, and similarly her chances of losing in the wrong state of the world. This effect is in line with the intuition that more polarized beliefs, or a more informed public (which is what, on aggregate, a behavioural society is), will induce more platform polarization. As shown above the concavity of the function G^N is behind this effect. Thus, Proposition 5 holds as long as N is not too large (we prove this formally in the appendix).

Below we use again Example 1 to show that for sufficiently many districts, polarization is larger in behavioural societies.

Example 1 revisited: We consider again Example 1 with the modified first order condition on polarization. We find that for $N = 3$ as above, polarization is still larger in a rational society although the difference in the platforms is smaller, whereas for $N = 5$, we have that $x_r^B = 0.43$ and $x_r^R = 0.39786$ and thus behavioural voters induce more polarization.

5 Extensions and discussion

We now consider several extensions of our analysis. We first consider some extensions related to the political model (such as strategic voting and turnout). We then conclude by considering another behavioural bias, confirmation bias, and show that our results do not follow. This analysis illustrates that the particular cognitive bias considered is important for the results.

5.1 The supply of information

A voter might receive signals and information as a result of communication with other agents, or by consumption of (potentially misleading) information provided by biased newspapers, interested parties, politicians etc. Our standard models of strategic information transmission, e.g., cheap talk, predict that individuals cannot be overwhelmingly manipulated, and that the messages they receive will be informative up to some level. As long as this is the case (which amounts to $q > 0.5$ in our model), our results will continue to hold.

Different information sources might also arise from competition in the media market. Suppose that there is at least one fixed source of information, a news agency such as AP or Reuters. Other newspapers then have to make a decision: whether to copy the report from the news agency, or to invest in their own quality journalists. The former action is cheap and allows the newspaper to charge a low price. The latter action is expensive for the newspapers. A market with such quality and price differentiation will fit the description of our model. That is, voters who buy the cheap newspapers and are also exposed to other news outlets are much more likely to hear or read repeated news whereas those that will read the quality newspapers that cost more will be more likely to obtain a new and independent signal. Our results in Section 4 imply that voters with some intermediate level of ideology may read more quality newspapers than voters with moderate or extreme ideology.

5.2 Pivotal voting

As the focus of this paper is on voters who are unable to process information correctly, assuming strategic voting might not be the most appropriate modelling assumption. The strategic voting model, in elections with incomplete information, implicitly assumes that voters are able to perform very sophisticated calculations about the information they learn from different vote tallies. For this reason, in the main part of the paper we assume that voters vote sincerely, which is the other common assumption about voting behaviour in the literature. For completeness, in this Section we show that our results also hold if one assumes that voting is strategic.

To this end, we need to consider a model with a finite population. Consider the case in which the two platforms are fixed, one at $x > 0$ and the other at $-x$, with $x \leq 1$. Now assume that there is a finite number n (odd) of voters. Each voter i has an ideal policy v_i distributed according to some $F(v_i)$ with density $f(v_i)$ symmetrically around the median 0 on $[-1, 1]$. The ideal policy v_i is private information of voter i. All the rest is as in our main model. We can then show:

Lemma 5: *In any symmetric equilibrium, the voting behaviour of any voter, whether rational or exhibiting correlation neglect, is the same as in Lemma 1.*

Thus, all our results follow if we consider strategic voting as well.

5.3 Turnout

Recent literature has used models in which voters turnout to vote if there is a large difference in the probabilities that each platform provides them with a high utility.[17] In our model this ties nicely with volatility of beliefs, as more volatile beliefs will induce a higher turnout. Our model predicts therefore that behavioural voters are more likely to participate in the election, which strengthens the results of Propositions 1 and 2. For example, suppose that the cost of voting is small and marginal. Behavioural voters have strong beliefs and none will abstain; some rational voters on the other hand will abstain and these will be the ones around the median and the extreme voters who have relatively weak beliefs. Our results rely however on intermediate voters where the voting patterns of behavioural and rational voters differ and are thus robust to this extension.

5.4 Confirmation bias

Correlation neglect, as noted by others (see Ortoleva and Snowberg 2013 or Glaeser and Sunstein 2009) leads to overconfidence, as agents become more convinced of their beliefs when the information which leads to it is repeated. Another potential source

[17] See for example Degan (2006).

of overconfidence is confirmation bias. Rabin and Schrag (1999) advocate a view of confirmation bias according to which agents interpret information which is contrary to their initial beliefs, in line with these beliefs.

We now provide a version of the political model with confirmation bias and show that an electorate of voters with such a bias will behave on the aggregate as a rational electorate. Therefore, our results depend on the particular behavioural bias assumed.

We maintain the same environment as in the main model, with two fixed platforms, $x > 0$ and $-x$, with $x \leq 1$. Assume now that voters are exposed to a sequence of two conditionally independent signals $s_i^0, s_i^1 \in \{-1, 1\}$ each with accuracy $q \geq \frac{1}{2}$. We say that an individual has *confirmation bias* (a-la Rabin and Schrag 1999), if whenever there is a conflict between the realisations of s_i^0 and s_i^1, then with probability $\rho(v_i) \in (0, 1)$ the individual believes that the realisation of s_i^1 is actually the same as s_i^0. When a voter is rational on the other hand, he fully recognizes the signal.[18]

Note that voters with confirmation bias will always believe that they have two independent signals. Therefore, voting behaviour is still given by Lemma 1. In particular, when they observe two signals s_i^0 and s_i^1, all individuals with $v_i \leq v_2$ vote for x unless $s_i^0 = s_i^1 = -1$, and all individuals in $[v_2, 1]$ always vote for x. Still, when compared to rational voters, there will be no change in the vote share for the correct outcome:

Proposition 6 *The vote shares in the model with voters with confirmation bias are the same as in the model with rational voters.*

The intuition for this result is the following. With confirmation bias, differences between the voting behaviours of the rational and the behavioural occur only when there is a mismatch between the two independent signals. As the two signals are ex ante symmetric, right-wing and left-wing voters “cancel” out the differences with a rational society.

On the other hand, with correlation neglect, the difference between behavioural and rational voters arises when the first signal is repeated. In this case left-wing and right-wing behavioural voters do not “cancel” each other but reinforce one another as both vote informatively based on the first signal. Thus, while both correlation neglect and confirmation bias induce overconfidence, modelling them explicitly allows us to arrive at different conclusions.

[18] Note that an alternative way to anchor the confirmation bias would be to let voters receive (or interpret) information in line with their initial ideology. However if the anchor is not based on any informative content, voters will vote less informatively than rational voters. In contrast, correlation neglect, by definition, has an informative anchor. For a better comparison with our model of correlation neglect we therefore assume that the anchor is informative.

Appendix

Proof of Lemma 1: It follows from quadratic utilities that an individual with a parameter v_i votes for $-x$ if the probability that $w = -1$ is sufficiently high which induces the cutoff points as described in the Lemma.$\blacksquare$

Proof of Proposition 2: Consider the average expected utility of all voters in some state ω :

$$\alpha \int_{-1}^{1} U(\omega, v_i, y) f(v_i) dv_i + \int_{-1}^{1} U(\omega, v_i, \tilde{y}) f(v_i) dv_i$$

Note that rational voters by definition maximise $U(\omega, v_i, \hat{y})$. Thus if α is small enough, rational voters do best. However, note that the vote share for the right outcome is higher for voters with correlation neglect given Proposition 1. If α is large enough, it is more important for voters that the right policy is chosen than that they vote for the right policy (in particular averaging over the utilities we effectively consider the utility of the median voter).$\blacksquare$

Proof of Proposition 3: Consider welfare from the outcome, which is the same as if considering the median voter. Suppose wlog that $\omega = 1$ and then we have as expected utility:

$$-V_x(1-x)^2 - (1-V_x)(1+x)^2$$

The optimal x is then

$$x = 2V_x - 1$$

and is therefore increasing in V_x, which is higher for the behavioural society (note that V_x only depends on ρ and the cutoffs which are not a function of x).$\blacksquare$

Proof of Lemma 2: From Figure 1 the difference between the two voting behaviours occur only in $[v_1 + \hat{x}, v_2 + \hat{x}]$ and in $[-v_2 + \hat{x}, -v_1 + \hat{x}]$ where $\hat{x} = \frac{x_r + x_l}{2}$ is the mid point between the two platforms in some equilibrium. Moreover, in these regions, with probability $1 - \rho(v)$, both electorates behave in the same way. Thus, letting $A(1, x_r)$ denote equal behaviour in both societies in state $\omega = 1$, we have (recall that $f(v) = \frac{1}{2}$):

$$V_{x_r}^B(1) = A(1, x_r) + \int_{-v_2+\hat{x}}^{-v_1+\hat{x}} \rho(v) q \frac{1}{2} dv + \int_{v_1+\hat{x}}^{v_2+\hat{x}} \rho(v) q \frac{1}{2} dv;$$
$$V_{x_r}^R(1) = A(1, x_r) + \int_{v_1+\hat{x}}^{v_2+\hat{x}} \rho(v) \frac{1}{2} dv$$

and therefore (note that $\frac{\partial \hat{x}}{\partial x_r} = \frac{1}{2}$ and that we evaluate the derivative at $\hat{x} = 0$) :

$$\frac{\partial V_{x_r}^B(1)}{\partial x_r} = \frac{\partial A(1, x_r)}{\partial x_r} + \frac{1}{4} q(\rho(-v_1) - \rho(-v_2) + \rho(v_2) - \rho(v_1)) = \frac{\partial A(1, x_r)}{\partial x_r};$$
$$\frac{\partial V_{x_r}^R(1)}{\partial x_r} = \frac{\partial A(1, x_r)}{\partial x_r} + \frac{1}{4}(\rho(v_2) - \rho(v_1))$$

which implies the result in the Lemma. It is easy to show how the derivation holds also when $w = -1$, as the difference above does not depend on the state of the world.■

Proof of Lemma 3:

Trivially voters with $v > v_2$ will not change their action when getting more information and will therefore choose $\rho = 1$.

We now look at voters with $v_i < v_1$. Their indirect utility from some ρ is (note that this is the same for rational individuals and behavioural individuals who think they are rational):

$$0.5(-(\rho q + (1-\rho)(1-(1-q)^2))(1+v-x)^2 - (\rho(1-q) + (1-\rho)(1-q)^2)(1+v+x)^2)$$
$$+0.5(-(\rho(1-q) + (1-\rho)(1-q^2))(-1+v-x)^2 - (\rho q + (1-\rho)q^2)(-1+v+x)^2)$$

The marginal benefit from ρ is:

$$\begin{aligned}&0.5(-(q-1+(1-q)^2))(1+v-x)^2 - ((1-q)-(1-q)^2)(1+v+x)^2)\\&+0.5(-((1-q)-(1-q^2))(-1+v-x)^2 - (q-q^2)(-1+v+x)^2) =\\&-4xvq(1-q)\end{aligned}$$

(Note that this is negative as a higher ρ reduces the information value). We then have

$$c'(1-\rho) = 4xvq(1-q)$$

with $\rho(v)$ decreasing in v for these types.

We now describe intermediate voters. Their indirect utility from some ρ is:

$$0.5(-(\rho + (1-\rho)(1-(1-q)^2))(1+v-x)^2 - (1-\rho)(1-q)^2(1+v+x)^2)$$
$$+0.5(-(\rho + (1-\rho)(1-q^2))(-1+v-x)^2 - (1-\rho)q^2(-1+v+x)^2)$$

The marginal benefit from ρ is:

$$2x\left(v - 2q + 2q^2v - 2qv + 1\right)$$

we therefore have that

$$c'(1-\rho) = 2x\left(v(-1+2q(1-q)) + 2q - 1\right)$$

note that here $\rho(v)$ increases with v and that we have continuity at v_1 and at v_2. Finally, it is easy to see the comparative statics as described in the Lemma.■

Proof of Propositions 4 and 5:

We first consider an analogue of Lemma 2 for the case of endogenous ρ.

Lemma 2a:

$$\frac{\partial V^R(1)}{\partial x_r} = -\frac{1}{4}\rho(v_1) + \int_{v_1}^{v_2} \frac{\partial \rho(v)}{\partial x_r}(1-2q)\frac{1}{2}dv;$$
$$\frac{\partial V^R(-1)}{\partial x_r} = -\frac{1}{4}\rho(v_1) - \int_{v_1}^{v_2} \frac{\partial \rho(v)}{\partial x_r}(1-2q)\frac{1}{2}dv;$$
$$\frac{\partial V^B(1)}{\partial x_r} = -\frac{1}{4} = \frac{\partial V^B(-1)}{\partial x_r}$$

(note that $\rho(v_2) = 1$ in the case of an endogenous ρ).

Proof of Lemma 2a:

Given Lemma 2, we only need to add the derivative of the vote shares with respect to the endogenous $\rho(v)$, evaluated at the midpoint $\hat{x} = 0$.

$V^R(1) =$
$\int_0^{2q-1+\hat{x}} (\rho(v)q + (1-\rho(v))(1-(1-q)^2))\frac{1}{2}dv +$
$\int_{1-2q+\hat{x}}^{0} (\rho(v)q + (1-\rho(v))q^2)\frac{1}{2}dv +$
$+\int_{2q-1+\hat{x}}^{\frac{2q-1}{q^2+(1-q)^2}+\hat{x}} (\rho(v) + (1-\rho(v))(1-(1-q)^2)\frac{1}{2}dv +$
$\int_{-\frac{2q-1}{q^2+(1-q)^2}+\hat{x}}^{-2q+1+\hat{x}} (1-\rho(v))q^2\frac{1}{2}dv + \int_{\frac{2q-1}{q^2+(1-q)^2}+p}^{1} \frac{1}{2}dv$
$V^B(1) =$
$\int_0^{2q-1+\hat{x}} (\rho(v)q + (1-\rho(v))(1-(1-q)^2))\frac{1}{2}dv +$
$\int_{1-2q+\hat{x}}^{0} (\rho(v)q + (1-\rho(v))q^2)\frac{1}{2}dv +$
$+\int_{2q-1+\hat{x}}^{\frac{2q-1}{q^2+(1-q)^2}+\hat{x}} (\rho(v)q + (1-\rho(v))(1-(1-q)^2)\frac{1}{2}dv +$
$\int_{-\frac{2q-1}{q^2+(1-q)^2}+\hat{x}}^{-2q+1+\hat{x}} (\rho(v)q + (1-\rho(v))q^2)\frac{1}{2}dv + \int_{\frac{2q-1}{q^2+(1-q)^2}+p}^{1} \frac{1}{2}dv$

First, given the specification in Lemma 2, we find from the above that $\frac{\partial A(1,x_r)}{\partial x_r} = \frac{\partial A(-1,x_r)}{\partial x_r} = 0$. We now proceed to take the derivative w.r.t. $\rho(v)$:

For $V^R(1)$ this equals:
$\int_0^{2q-1} \frac{\partial \rho(v)}{\partial x_r}(q-1+(1-q)^2)\frac{1}{2}dv +$
$\int_{1-2q}^{0} \frac{\partial \rho(v)}{\partial x_r}(q-q^2)\frac{1}{2}dv + \int_{2q-1}^{\frac{2q-1}{q^2+(1-q)^2}} \frac{\partial \rho(v)}{\partial x_r}(1-2q)\frac{1}{2}dv$
$= \int_{2q-1}^{\frac{2q-1}{q^2+(1-q)^2}} \frac{\partial \rho(v)}{\partial x_r}(1-2q)\frac{1}{2}dv$

For $V^R(-1)$ this equals:
$\int_0^{2q-1} \frac{\partial \rho(v)}{\partial x_r}(1-q-1+q^2)\frac{1}{2}dv +$
$\int_{1-2q}^{0} \frac{\partial \rho(v)}{\partial x_r}(1-q-(1-q)^2)\frac{1}{2}dv - \int_{2q-1}^{\frac{2q-1}{q^2+(1-q)^2}} \frac{\partial \rho(v)}{\partial x_r}(1-2q)\frac{1}{2}dv$
$= -\int_{2q-1}^{\frac{2q-1}{q^2+(1-q)^2}} \frac{\partial \rho(v)}{\partial x_r}(1-2q)\frac{1}{2}dv$

and for $V^B(1)$ and $V^B(-1)$ this derivative equals 0. In fact, as the accuracies of the two signals are the same, the aggregate vote share for the behavioural agents does not depend on ρ (in the symmetric distribution $\rho(v)$ case). Putting together the results in Lemma 2 (for exogenous ρ) and the derivatives w.r.t. $\rho(v)$ proves the Lemma.■

We proceed in the more general case, which includes a general concave and symmetric $G(V)$ function, such as the one introduced in Section 4.3.

Lemma 2b: For both endogenous and exogenous $\rho(v)$, when G is symmetric, the symmetric equilibrium first order condition for symmetric x_r, x_l is

$$\frac{\partial G(V^J(1))}{\partial V^J(1)} 2K^J \Delta_{U_r}(x_r, x_l) + \frac{\partial U_r(x_r)}{\partial x_r}\frac{1}{2} = 0 \tag{3}$$

where $K^B = -\frac{1}{4}$ and $K^R = -\frac{1}{4}\rho(v_1)$.

This follows from the symmetry of the model in the state of the world, the symmetric equilibrium, and the symmetry of G which imply together that $\frac{\partial G(V^J(1))}{\partial V^J(1)} = \frac{\partial G(V^J(-1))}{\partial V^J(-1)}$. With the last statement of Lemma 2a, Lemma 2b follows.■

As (3) holds for both the case of an endogenous ρ and the case of an exogenous ρ, Proposition 5 will be a special case of Proposition 4. We are now ready to prove a general version of Proposition 4.

Suppose first that $\rho(v_1) > \rho(v_2)$. Consider an equilibrium of the rational model x_r^R, x_l^R. Evaluated at these points, we would have $0 > \frac{\partial G(V^B(1))}{\partial V^B(1)} K^B > \frac{\partial G(V^R(1))}{\partial V^R(1)} K^R$ because: (a) $V^B(1) > V^R(1)$ by Proposition 1 implying by the properties of G that $0 \leq \frac{\partial G(V^B(1))}{\partial V^B(1)} \leq \frac{\partial G(V^R(1))}{\partial V^R(1)}$; (b) $0 > K^B > K^R$ as we have that $\rho(v_1) > \rho(v_2)$. Thus we will have more polarization with behavioural societies.

Suppose now that $\rho(v_1) < \rho(v_2)$ (as is the case for Proposition 5). We then have $K^B < K^R$. Consider $G(V) = V$. We then have that $\frac{\partial G(V^J(1))}{\partial V^J(1)} = 1$ but $K^B < K^R < 0$ implying that at some equilibrium x_r^R, x_l^R of the rational model, when we evaluate the FOC of the behavioural model at these values, we have that the *lhs* of (3) is smaller than that of the rational model and thus negative (as for the rational it is zero in the postulated equilibrium). We will have therefore less polarization with behavioural voters.[19] Note that when G is not too concave and close to the linear one, the result above would hold insuring robustness.■

Calculations for Example 1:

Suppose that $x = 0.5, c(1-\rho) = 0.5\gamma(1-\rho)^2$ and $\gamma = 2$ and consider a uniform

[19] As K^B and K^R are bounded from zero, we can also find a G such that $\frac{\partial G(V^B(1))}{\partial V^B(1)} K^B > \frac{\partial G(V^R(1))}{\partial V^R(1)} K^R$ and there will be an equilibrium with more polarisation when voters are behavioural for this G.

distribution over voters. For behavioural voters, the vote share for the right option is

$$\int_{-v_2}^{0}(\rho(v)q+(1-\rho(v))q^2 f(v)dv+\int_{0}^{v_2}(\rho(v)q+(1-\rho(v))(1-(1-q)^2)f(v)dv+\int_{v_2}^{1}f(v)dv$$
$$=\int_{0}^{v_2}(2\rho(v)q+(1-\rho(v))(1-(1-q)^2+q^2)f(v)dv+\int_{v_2}^{1}f(v)dv$$
$$=\frac{1}{2}+\int_{0}^{v_2}(q^2-(1-q)^2)f(v)dv$$

whereas for rational voters it is

$$\int_{-v_2}^{-v_1}(1-\rho(v))q^2 f(v)dv+\int_{-v_1}^{0}(\rho(v)q+(1-\rho(v))q^2)f(v)dv$$
$$+\int_{0}^{v_1}(\rho(v)q+(1-\rho(v))(1-(1-q)^2)f(v)dv+\int_{v_1}^{v_2}(\rho(v)+(1-\rho(v))(1-(1-q)^2)f(v)dv$$
$$+\int_{v_2}^{1}f(v)dv$$
$$=\int_{0}^{v_1}(2\rho(v)q+(1-\rho(v))(1-(1-q)^2+q^2)f(v)dv$$
$$+\int_{v_1}^{v_2}(\rho(v)+(1-\rho(v))(1-(1-q)^2+q^2)f(v)dv+\int_{v_2}^{1}f(v)dv$$
$$=\frac{1}{2}+\int_{0}^{v_2}(q^2-(1-q)^2)f(v)dv-\int_{v_1}^{v_2}\rho(v)(q^2-(1-q)^2)f(v)dv$$

Thus, for behavioural voters, the vote share for the right option is $\frac{1}{2}+\int_0^{\frac{2q-1}{q^2+(1-q)^2}}(q^2-(1-q)^2)\frac{1}{2}dv=\frac{\left(3q^2-3q+1\right)}{2q^2-2q+1}=0.7$ and for rational voters it is $\frac{\left(3q^2-3q+1\right)}{2q^2-2q+1}-(q^2-(1-q)^2)0.5\int_{2q-1}^{\frac{2q-1}{q^2+(1-q)^2}}\rho(v)dv=0.628\,52$ as $\rho(v)=1-2x\frac{(v(-1+2q(1-q))+2q-1)}{\gamma}=0.312\,5v+0.75$.

Suppose that the state is 1. For the outcome component of the utility function, expected utility for rational voters is: $-\alpha(1-0.628\,52)\int_{-1}^{1}(1+v+x)^2 0.5dv-\alpha 0.628\,52\int_{-1}^{1}(1+v-x)^2 0.5dv=-1.3263\alpha$, and for behavioural voters it is $-\alpha(1-0.7)\int_{-1}^{1}(1+v+x)^2 0.5dv-\alpha 0.7\int_{-1}^{1}(1+v-x)^2 0.5dv=-1.1833\alpha$.

Note that the cost component is the same for both societies. We therefore now consider the utilities from voting for the right option. Note that moderates and extremists vote in the same way, and hence we only have to consider the differences in utilities for intermediate voters in $[v_1,v_2]$ and $[-v_2,-v_1]$.

For the rational voters this is:

$$-\int_{2q-1}^{\frac{2q-1}{q^2+(1-q)^2}}((0.312\,5v+0.75)+(0.25-0.3125v)(1-(1-q)^2))(1+v-x)^2 0.5dv$$
$$-\int_{2q-1}^{\frac{2q-1}{q^2+(1-q)^2}}(0.25-0.3125v)(1-q)^2(1+v+x)^2 0.5dv$$
$$-\int_{-\frac{2q-1}{q^2+(1-q)^2}}^{1-2q}(0.25-0.3125v)q^2(1+v-x)^2 0.5dv$$

$- \int_{-\frac{2q-1}{q^2+(1-q)^2}}^{1-2q} ((0.312\,5v + 0.75) + (0.25 - 0.3125v)(1 - q^2))(1 + v + x)^2 0.5dv$
$= -0.284\,04$

And for the behavioural voters it is:
$- \int_{2q-1}^{\frac{2q-1}{q^2+(1-q)^2}} ((0.312\,5v + 0.75)q + (0.25 - 0.3125v)(1 - (1-q)^2))(1 + v - x)^2 0.5dv$
$- \int_{2q-1}^{\frac{2q-1}{q^2+(1-q)^2}} ((0.312\,5v + 0.75)(1-q) + (0.25 - 0.3125v)(1-q)^2)(1 + v + x)^2 0.5dv$
$- \int_{-\frac{2q-1}{q^2+(1-q)^2}}^{1-2q} ((0.312\,5v + 0.75)q + (0.25 - 0.3125v)q^2)(1 + v - x)^2 0.5dv$
$- \int_{-\frac{2q-1}{q^2+(1-q)^2}}^{1-2q} ((0.312\,5v + 0.75)(1-q) + (0.25 - 0.3125v)(1 - q^2))(1 + v + x)^2 0.5dv$
$= -0.358\,57$

To find $\bar{\alpha}$, we equate $-0.35857 - 1.1833\alpha = -0.28404 - 1.3263\alpha$, and the solution is $\bar{\alpha} = 0.52119$.

We now consider endogenous platforms.

Suppose that $c(1-\rho) = 0.5\gamma(1-\rho)^2$ and $\gamma = 2$ and consider a uniform distribution over voters. Suppose that $U_r(y) = -(1-y)^2$ and $U_l(y) = -(-1-y)^2$.

For the behavioural model, the first order condition w.r.t. x_r, evaluated at $-x_l = x_r = x$, is: $(-0.25)4x + 0.5(2(1-x)) = 0$, where the solution is $x = 0.5$ as above.

Second order condition w.r.t. x_r evaluated at $x_r = x$ is $-2(1-x) - 1 < 0$ and thus this is the unique equilibrium. The average welfare of voters when the state is $\omega = 1$ is (now the information acquisition changes across the models so we have to compute all expressions):
$- \int_{\frac{2q-1}{q^2+(1-q)^2}}^{1} (1 + v - x)^2 0.5dv - \int_{-1}^{-\frac{2q-1}{q^2+(1-q)^2}} (1 + v + x)^2 0.5dv$
$- \int_{0}^{2q-1} ((1 - 0.375v)q + (0.375v)(1 - (1-q)^2))(1 + v - x)^2 0.5dv$
$- \int_{0}^{2q-1} ((1 - 0.375v)(1-q) + (0.375v)(1-q)^2)(1 + v + x)^2 0.5dv$
$- \int_{1-2q}^{0} ((1 - 0.375v)q + (0.375v)q^2)(1 + v - x)^2 0.5dv$
$- \int_{1-2q}^{0} ((1 - 0.375v)(1-q) + (0.375v)(1 - q^2))(1 + v + x)^2 0.5dv$
$- \int_{1-2q}^{2q-1} \gamma(0.375v)^2 0.5(0.5)dv - \int_{2q-1}^{\frac{2q-1}{q^2+(1-q)^2}} \gamma(0.25 - 0.3125v)^2 0.5dv$
$= -1.1833\alpha - 0.99707$

And now for the rational society, the first order condition is $(-0.25(1 - \frac{0.375x}{\gamma}))4x + 0.5(2(1-x)) = 0$, solution is $x = 0.526$. The second order condition is $(-(1 - \frac{0.375x}{\gamma}))2(1-x) - 1 - x\frac{\partial\rho(v_1)}{\partial x_r}$, with $\frac{\partial\rho(v_1)}{\partial x_r} < 0$. Note however that $\rho(v_1) = 1 - (x_l + x_r)\frac{(v_1(-1+2q(1-q))+2q-1)}{\gamma}$ and thus $\frac{\partial\rho(v_1)}{\partial x_r} = -\frac{((2q-1)(-1+2q(1-q))+2q-1)}{\gamma} = -0.09375$ which is very small and hence SOC is satisfied.

The probability of taking the correct decision is similar to the case in which platforms were fixed:
$\frac{(3q^2-3q+1)}{2q^2-2q+1} - (q^2 - (1-q)^2)0.5 \int_{2q-1}^{\frac{2q-1}{q^2+(1-q)^2}} (1 - 2x\frac{(v(-1+2q(1-q))+2q-1)}{\gamma})dv = 0.62870$

The average welfare is then:

$-\alpha(1-0.62870)\int_{-1}^{1}(1+v+x)^2 0.5dv - \alpha 0.62870\int_{-1}^{1}(1+v-x)^2 0.5dv$
$-\int_{2q-1}^{\frac{2q-1}{q^2+(1-q)^2}}((0.328\,75v+0.737)+(0.263\ -0.328\,75v)(1-(1-q)^2))(1+v-x)^2 0.5dv$
$-\int_{2q-1}^{\frac{2q-1}{q^2+(1-q)^2}}(0.263\ -0.328\,75v)(1-q)^2(1+v+x)^2 0.5dv$
$-\int_{-\frac{2q-1}{q^2+(1-q)^2}}^{1-2q}(0.263\ -0.328\,75v)q^2(1+v-x)^2 0.5dv$
$-\int_{-\frac{2q-1}{q^2+(1-q)^2}}^{1-2q}((0.328\,75v+0.737)+(0.263\ -0.32875v)(1-q^2))(1+v+x)^2 0.5dv$
$-\int_{\frac{2q-1}{q^2+(1-q)^2}}^{1}(1+v-x)^2 0.5dv - \int_{-1}^{-\frac{2q-1}{q^2+(1-q)^2}}(1+v+x)^2 0.5dv$
$-\int_{0}^{2q-1}((1-0.3945v)q+(0.3945v)(1-(1-q)^2))(1+v-x)^2 0.5dv$
$-\int_{0}^{2q-1}((1-0.3945v)(1-q)+(0.3945v)(1-q)^2)(1+v+x)^2 0.5dv$
$-\int_{1-2q}^{0}((1-0.3945v)q+(0.3945v)q^2)(1+v-x)^2 0.5dv$
$-\int_{1-2q}^{0}((1-0.3945v)(1-q)+(0.3945v)(1-q^2))(1+v+x)^2 0.5dv$
$-\int_{1-2q}^{2q-1}\gamma(0.3945v)^2 0.5(0.5)dv - \int_{2q-1}^{\frac{2q-1}{q^2+(1-q)^2}}\gamma(0.263\ -0.32875v)^2 0.5dv$
$=-1.3392\alpha-0.91289$

Comparing the two welfare expressions we have that $-1.3392\alpha-0.91289=-1.1833\alpha-0.99707$, Solution is: $\alpha=0.539\,96$.

Finally, for the case of multi-district societies, we repeat these calculations for $N=5$, for which $\frac{\partial}{\partial V}\sum_{i=\frac{N+1}{2}}^{N}\binom{N}{i}(V)^i(1-V)^{N-i}=30V^2(V-1)^2$. Adding these to the first order conditions specified above we find that $x_r^B=0.430\,48$ and $x_r^R=0.39786$. For a very large N, x_r^B and x_r^R converge to 1.■

Proposition A1: *Consider sophisticated voters with correlation neglect and $v_i\geq 0$ (all types with $v_i\leq 0$ will have symmetric behaviours): (i) All individuals with $v_i\in[0,v_2]$ invest in information (and only these voters) with investment increasing with v_i. (ii) They all acquire (weakly) more information than rational or naive-behavioural voters; they therefore have less volatile beliefs compared with naive-behavioural voters but still more volatile beliefs compared with rational voters.*

Proof of Proposition A1: First, the choice of ρ for the sophisticated-behavioural is according to the following indirect utility function for all types in $[0,v_2]$:

$$0.5(-(\rho q+(1-\rho)(1-(1-q)^2))(1+v-x)^2-(\rho(1-q)+(1-\rho)(1-q)^2)(1+v+x)^2)$$
$$+0.5(-(\rho(1-q)+(1-\rho)(1-q^2))(-1+v-x)^2-(\rho q+(1-\rho)q^2)(-1+v+x)^2)$$

Note that this holds for all types in $[0,v_2]$ because the sophisticated behavioural voter in $[v_1,v_2]$ realizes that with probability ρ they will act on the basis of the first signal.

The marginal benefit w.r.t. ρ is therefore:

$$c'(1-\rho)=4qvx\,(1-q)$$

which implies that ρ is decreasing in v. We will therefore have the same ρ for all voters (rational, naive and sophisticated) for all $v \leq 2q-1$.$\blacksquare$

Proof of Lemma 4: It is trivial to derive the expression and to show that it is concave on $V_x \in [0.5, 1]$. To see that it becomes more concave when N grows large, note that in the limit, $G^N(V_x) \to 1$ for $V_x > 0.5$ which by continuity and concavity for all N implies that the function becomes more concave with N.$\blacksquare$

Proof of Lemma 5: Note that vote shares in this model are stochastic. In particular, assume cutoffs v_1 and v_2 as in Lemma 1, the probability a random (Rational R, behavioural B) voter votes for x when the state is 1 is given by:

$$\begin{aligned}
\gamma_x^B(1) &= (1-F(-v_2)) + (F(v_2)-\frac{1}{2})(\rho q + (1-\rho)(1-(1-q)^2) + (\frac{1}{2}-F(-v_2))(\rho q + (1-\rho)q^2) \\
\gamma_x^R(1) &= (1-F(-v_2)) + (F(v_2)-F(v_1))(\rho + (1-\rho)(1-(1-q)^2)) + \\
&\quad (F(v_1)-\frac{1}{2})(\rho q + (1-\rho)(1-(1-q)^2) \\
&\quad +(\frac{1}{2}-F(-v_1))(\rho q + (1-\rho)q^2) + (F(-v_1)-F(-v_2))((1-\rho)q^2)
\end{aligned}$$

Similarly one can define $\gamma_x^B(-1)$ and $\gamma_x^R(-1)$.

The probability of vote share $v = \frac{m}{n}$ for R in state 1 is given by,

$$\Pr(v = \frac{m}{n}|J, w=1) = \begin{pmatrix} m \\ n \end{pmatrix} (\gamma_x^J(1))^m (1-\gamma_x^J(1))^{n-m}$$

We now define, for a voter of type v_i and with information Ω, the difference in expected utility from voting to x and $-x$, denoted by $\Delta(v_i|\Omega)$.

Note below that

$(x-(v+1))^2 - (-x-(v+1))^2 = -4x\,(v+1)$ and

$(x-(v-1))^2 - (-x-(v-1))^2 = -4x\,(v-1)$. We will also prove the Lemma for a general $G(V)$.

$$\begin{aligned}
&\Delta(v_i|\Omega) = -\Pr(w=1|\Omega)[\\
&\sum_{m=0}^{\frac{n+1}{2}} \begin{pmatrix} m \\ n \end{pmatrix} (\gamma_x^J(1))^m (1-\gamma_x^J(1))^{n-m} (G(\tfrac{n-m}{n}) - G(\tfrac{n-m-1}{n}))(-4x\,(v+1)) \\
&+ \sum_{m=\frac{n+1}{2}}^{n-1} \begin{pmatrix} m \\ n \end{pmatrix} (\gamma_x^J(1))^m (1-\gamma_x^J(1))^{n-m} (G(\tfrac{m+1}{n}) - G(\tfrac{m}{n}))(-4x\,(v+1))] \\
&-\Pr(w=-1|\Omega)[\\
&\sum_{m=0}^{\frac{n-1}{2}} \begin{pmatrix} m \\ n \end{pmatrix} (\gamma_x^J(-1))^m (1-\gamma_x^J(-1))^{n-m} (G(\tfrac{n-m}{n}) - G(\tfrac{n-m-1}{n}))(-4x\,(v-1))
\end{aligned}$$

$$+\sum_{m=\frac{n+1}{2}}^{n-1}\binom{m}{n}(\gamma_x^J(-1))^m(1-\gamma_x^J(-1))^{n-m}(G(\tfrac{m+1}{n})-G(\tfrac{m}{n}))(-4x\,(v-1))]$$

$$=-\Pr(w=1|\Omega)[$$

$$\sum_{m=\frac{n+1}{2}}^{n-1}\binom{m}{n}(\gamma_x^J(1))^m(1-\gamma_x^J(1))^{n-m}-(\gamma_x^J(1))^{n-m}(1-\gamma_x^J(1))^m)(G(\tfrac{m+1}{n})-G(\tfrac{m}{n}))(-4x\,(v+1))$$

$$-\Pr(w=-1|\Omega)[$$

$$\sum_{m=0}^{\frac{n-1}{2}}\binom{m}{n}(\gamma_x^J(-1))^m(1-\gamma_x^J(-1))^{n-m}-(\gamma_x^J(-1))^{n-m}(1-\gamma_x^J(-1))^m)(G(\tfrac{m+1}{n})-G(\tfrac{m}{n}))(-4x\,(v-1))$$

By Symmetry,

$$\Delta_{R-L}(v|\Omega)=[-\Pr(w=1|\Omega)(-4x\,(v+1))-\Pr(w=-1|\Omega)(-4x\,(v-1))]\{\sum_{m=\frac{n+1}{2}}^{n-1}\binom{m}{n}(\gamma_x^J(1))^m(1-\gamma_x^J(1))^{n-m}-(\gamma_x^J(1))^{n-m}(1-\gamma_x^J(1))^m)(G(\tfrac{m+1}{n})-G(\tfrac{m}{n}))\}$$

and so

$$sign\{\Delta_{R-L}(v|\Omega)\}=sign\{[-\Pr(w=1|\Omega)(-4x\,(v+1))-\Pr(w=-1|\Omega)(-4x\,(v-1))]\}$$

where the argument in the right hand side is the same as that we have assumed in the main paper for a voter who derives utility from voting sincerely.■

Proof of Proposition 6: Suppose with out loss of generality that $\omega=1$. Voters in $[0,v_2]$ will vote for x unless they observe two -1 signals, which happens with probability $(1-q)^2$ for rationals but with probability $(1-q)(1-q+q\rho(v))>(1-q)^2$ for behavioural. The difference is then $q(1-q)\rho(v)$. But note that voters in $[-v_2,0]$ will vote for x only if they see two 1 signals, which happens with probability q^2 for rationals and $q(q+(1-q)\rho(v))>q^2$ for behaviourals. The difference in these probabilities is again $q(1-q)\rho(v)$. Therefore, if the distribution of voters is symmetric we will have the same vote shares for rational voters and for those with confirmation bias.■

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