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# Correlation Neglect, Voting Behaviour and Information Aggregation

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Abstract: In this paper we analyse elections when voters underestimate the correlation between their information sources (“correlation neglect”). We find that this cognitive bias can improve political outcomes. We show that the extreme beliefs which result from correlation neglect induce some voters to base their vote on information rather than on political preferences. We characterise conditions on the distribution of preferences under which this induces higher vote shares for the optimal policies and better information aggregation.

## 1 Introduction

A large literature in Political Science has documented the incompetency of voters in collecting and processing information. Voters have been shown to be poorly informed about what they vote on (Campbell et al 1960, Kinder and Sears 1985, Bartels 1996 and Delli, Carpini and Keeter 1996) and to use the information they do have incorrectly (Achen and Bartels 2004, Wolfers 2009, Leigh 2009, Healy, Malhotra and Mo 2010, Huber, Hill and Lenz 2012, and Lau and Redlawsk 2001). As 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.”

While there is a consensus about voters being misinformed, the implication of this for political outcomes is not obvious. Some have suggested that voters compensate for this by using cues and information short-cuts to arrive at informed voting decisions (Lupia 1994, Popkin 1991).<sup>2</sup> Others, on the other hand, show how large electorates take decisions that are far from an informed ideal.<sup>3</sup> Caplan (2007) claims that voters make systematic errors, arising from incorrect beliefs, and thus elections fail to aggregate information.<sup>4</sup>

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<sup>2</sup>Popkin (1991) has coined the term “low-information signalling” to describe how voters are able to make rational choices between candidates by using information short-cuts.

<sup>3</sup>See Bartels (1996), Druckman (2012) and Taber et al (2006).

<sup>4</sup>For a recent and thorough survey of this literature see Ashworth and Bueno de Mesquita (forthcoming).

In this paper we argue that voters’ incorrect beliefs might actually improve voting outcomes. To do so, we focus on incorrect beliefs which arise due to the cognitive bias of correlation neglect (De Marzo et al 2003, Ortoleva and Snowberg, forthcoming, and Glaeser and Sunstein 2009). This cognitive bias implies that individuals neglect the level of correlation between the different sources of information they are exposed to.<sup>5</sup> We characterise how incorrect beliefs due to correlation neglect affect voting behaviour. We then compare the information aggregation properties of elections in electorates with such voters to electorates with rational voters (who are aware of the correlation of their sources of information).

Specifically, we analyse a voting model with heterogeneous voters who have to choose between two policies, one on the right and one on the left, using majority rule. Voters’ ideal policies depend on their preference parameters, and an unknown state, which is the same for all voters. All voters prefer the policy on the right in a right-wing state of the world, and the policy on the left in a left-wing state of the world, albeit with different intensities. Each voter receives signals about the state of the world and makes voting decisions given this information and her preferences. We assume that signals might be correlated but that “behavioural” voters neglect the correlation in these sources, while rational voters do not.

Our result is that correlation neglect can be –and is, in many standard environments– beneficial for information aggregation: Even if each behavioural voter does not vote optimally from her own point of view (compared to a rational voter), the whole electorate may reach better, more informed, outcomes (compared to a rational electorate).

Intuitively, correlation neglect magnifies the effect of information on individuals’ behaviour. Individuals who might otherwise stick with the policy that accords with the direction of their political preferences may be swayed to change their vote if they believe that their information is sufficiently strong in the opposite direction. This implies that individuals base their vote more on their information rather than on their preferences.

For relatively symmetric distributions of preferences, more informative voting implies that the vote share for the optimal policy is higher in the behavioural electorate in both states of the world. More generally, whether the vote share for the optimal policy is higher in a behavioural electorate, and in which state, depends on the distribution of preferences. We find that when the distribution of preferences is skewed, correlation neglect tends to work against that. For example, if the electorate is somewhat leaning to the *right*, the vote share for the optimal policy in the *left* state of the world is higher in a behavioural

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<sup>5</sup>In the context of financial markets, Eyster and Weizsacker (2012) conduct an experiment to show that individuals neglect correlation when choosing a portfolio. See also Kallir and Sonsino (2009) and Enke and Zimmermann (2013).

electorate compared to a rational one. This implies that the potential advantage of the behavioural electorate can be maintained with non-symmetric distributions of preferences. If the electorate leans to the right, then when the optimal policy is to the right, it will be chosen whether voters neglect correlation or not. However, when the optimal policy is to the left, it may be chosen by a behavioural electorate when it would not be chosen by a rational one.

To illustrate the implication of the above, we consider an environment with aggregate shocks to voters' preferences. Specifically, voters' preferences might shift to the right or to the left (in a monotone likelihood ratio sense). We show that for each such distribution a behavioural electorate aggregates either the same or more information compared with a rational electorate. Thus, *ex ante*, in such environments, a behavioural electorate aggregates strictly more information than a rational one.

This paper is related to a recent literature on correlation neglect. In Ortoleva and Snowberg (forthcoming) 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 neglect correlation. 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.

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 a group may perform worse than an individual decision maker.<sup>6</sup> Our results are complementary to theirs. In our model, information is aggregated through voting. Individuals with correlation neglect overweigh their information and therefore vote more informatively. Such voting decisions are wrong for the individual but in the aggregate, produce more informative outcomes. In Glaeser and Sunstein (2009) on the other hand, information is shared among the members of the group *prior* to the decision being taken. This implies that the whole group acts as an individual who neglects the correlation across the signals and therefore makes the wrong decision.

Our analysis also contributes to the literature on group decision making with Bayesian failures or cognitive biases. For example, Benabou (2013) and Bolton, Brunermeir and Veldkamp (2013) show the benefits of overconfidence, while Ashworth and Bueno de Mesquita (forthcoming) provide examples under which behavioural biases might be beneficial for voters when one takes into account the strategic behaviour of politicians.

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<sup>6</sup>For some experimental studies see Brown (1986) and Schkade, Sunstein and Kahneman (2000).

## 2 The Model

An electorate composed of a continuum of voters needs to choose between two policies  $r$  and  $l$  where  $r \in [0, 1]$  and  $l = -r$ . Each voter  $i$  has a preference parameter  $v_i$  distributed according to some full support  $F(v_i)$  with density  $f(v_i)$  on  $[-1, 1]$ . The utility of the voters, specified below, will also depend on the chosen policy as well as on the realisation of a state of the world,  $\omega \in \{-1, 1\}$ . The common prior is that each state occurs with equal probability.<sup>7</sup>

**The information structure:** We analyse the simplest environment that allows us to consider correlation neglect. Assume that each voter  $i$  receives two private signals  $s_i^1, s_i^2 \in \{-1, 1\}$ . A signal  $s_i^j$ ,  $j \in \{1, 2\}$ , has accuracy  $q \geq \frac{1}{2}$ , that is,  $\Pr(s_i^j = \omega | \omega) = q$ . With probability  $\rho$ , the signals  $s_i^1, s_i^2$  are fully correlated, and with probability  $1 - \rho$ , they are (conditionally) independent.<sup>8</sup>

In what follows we compare “behavioural” voters to rational voters. We assume that a behavioural voter does not understand that the signals might be correlated. Such a voter always believes that the signals are conditionally independent. A rational voter on the other hand, is aware of the information structure, and specifically also fully recognizes when the signals are fully correlated and when they are independent.<sup>9</sup>

Note that compared with a rational voter, the beliefs of a behavioural voter would be wrong in the sense that they would be too extreme; when the signals are correlated, the voter would believe he has two signals pointing in one direction, where in truth there is only one such signal.<sup>10</sup>

Below we will compare two types of electorates. A *rational electorate* consists of rational voters and a *behavioural electorate* consists of behavioural voters.<sup>11</sup>

**The political environment and utilities:** Upon the realization of the signals  $s_i^1$  and  $s_i^2$ , and given their posterior beliefs, voters vote either for platform  $r$  or for  $l$ . Let  $V_y^J(\omega)$  denote the vote share for policy  $y \in \{r, l\}$  in state  $\omega$  for an electorate  $J \in \{R, B\}$ , that is, when the electorate has rational and behavioural voters respectively. We assume a simple

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<sup>7</sup>Given that we consider general distributions of preferences, the symmetry of the policies and of the prior is a normalization.

<sup>8</sup>Our analysis can be extended to the introduction of many signals and states of the world, to a more complicated correlation structure and to different degrees of accuracies or correlation levels of the signals.

<sup>9</sup>The assumption that a rational voter fully recognizes when the signals are fully correlated is made for simplicity; we can assume instead that he takes the probability  $\rho$  into consideration in his Bayesian updating.

<sup>10</sup>See also Ortoleva and Snowberg (forthcoming) and Glaeser and Sustein (2009).

<sup>11</sup>It will be clear from the analysis that it is sufficient to focus on the two extreme cases and results for mixed electorates can be easily derived.

majority rule so that policy  $y$  wins under electorate  $J$  in state  $\omega$  if  $V_y^J(\omega) > \frac{1}{2}$  and with some probability if  $V_y^J(\omega) = \frac{1}{2}$ .

Denote by  $y^*$  the policy that is chosen in the election. As is standard, we assume that a voter with a preference parameter  $v_i$  derives a higher utility from the political outcome being closer to her ideal policy  $\omega + v_i$ . Specifically, a voter's expected utility is given by

$$E_\omega(-(\omega + v_i - y^*)^2).$$

Note that we assume that  $v_i \in [-1, 1]$ , hence for all voters, policy  $l$  is optimal in state  $\omega = -1$  and policy  $r$  is optimal in state  $\omega = 1$ . Thus the *optimal policy* “matches” the state of the world and all voters agree on the optimal policy conditional on the state.

**Voting strategies:** Note that as we have a continuum of voters, each voter is pivotal with probability zero. We assume that voters vote sincerely, so that voter  $v_i$  votes for  $r$  iff  $E_\omega[-(\omega + v_i - r)^2] \geq E_\omega[-(\omega + v_i - l)^2]$ . An alternative assumption could have been to model a finite population and analyse strategic voting. Such a model can be shown to yield similar results.<sup>12</sup> However, as the focus of this paper is on voters who are unable to process information correctly, strategic voting -which involves sophisticated cognitive capabilities- might not be the most appropriate modelling assumption.

**Information Aggregation:** Let  $p^J(\omega)$  be the probability that the optimal policy in state  $\omega$  is chosen when the electorate is of type  $J \in \{R, B\}$ . We say that an electorate of type  $J$  *aggregates more information* than an electorate of type  $J'$  if  $p^J(\omega) \geq p^{J'}(\omega)$  for  $\omega \in \{-1, 1\}$ , with one of these inequalities strict. When  $p^J(\omega) = p^{J'}(\omega)$  for  $\omega \in \{-1, 1\}$ , we will say that the electorates of type  $J$  and  $J'$  *aggregate the same level of information*.

While information aggregation is interesting in its own right, it also has strong normative implications in our model. As all voters are in  $[-1, 1]$ , better information aggregation implies a Pareto improvement. For other environments (where for example for some voters the right policy is always optimal), our positive results hold and information aggregation can be normatively motivated by an equivalence to a model in which the whole electorate knows the aggregated information. See Feddersen and Pesendorfer (1997) for a similar notion of “full information equivalence”. Moreover, in some more general environments, such as relatively symmetric ones, better information aggregation will still imply higher average welfare.

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<sup>12</sup>We show this in an online appendix. For a model with finite population and strategic voters (who learn from being pivotal), we show that when the distribution of preferences is symmetric then a behavioural electorate induces more information aggregation than a rational one, that this is robust to asymmetric perturbations, and, using an example, that this holds for large asymmetries as well.

### 3 Voting behaviour and vote shares

We now characterize the voting behaviour of rational and behavioural voters. To this end, it will be enough to look at the cases in which voters have one signal, or believe that they have two conditionally independent signals. Let

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

The results below pertain to voters in  $[0, 1]$ , where the results for voters with  $v_i \in [-1, 0]$  are derived in a similar fashion.<sup>13</sup>

**Lemma 1:** *Consider all voters with  $v \in [0, 1]$ . (i) One signal: A voter with  $v < v'$  who observes only one signal votes  $r$  ( $l$ ) if the signal is 1 ( $-1$ ). A voter with  $v > v'$  who observes only one signal votes for  $r$ . (ii) Two signals: A voter with  $v < v''$  who believes he has two independent signals votes for  $r$  unless the two signals are  $-1$ . A voter with  $v > v''$  always votes for  $r$ .*

Note that whether a voter is rational or behavioural will matter only when the signals are correlated, that is, with probability  $\rho$ . Suppose that the state is  $\omega = 1$ . The figure below shows the probability that different voters cast the vote for the optimal policy  $r$ , as derived from Lemma 1, when the signals are correlated:

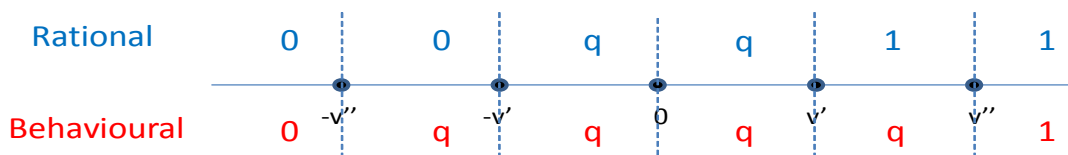


Figure 1: The probability that each voter votes for  $r$  in state  $\omega = 1$  in the event that the signals are correlated.

As can be seen in the figure, a voter with  $v > v''$  will vote for  $r$  no matter how she processes information. This occurs as her strong preference parameter overwhelms even two  $-1$  signals (analogously, a voter with  $v < -v''$  will always vote  $l$ ). Consider now a moderate voter in  $[0, v']$ . Again, such a voter would behave in the same way disregarding how she processes information. To see this, note that when the signals are fully correlated, and she is rational, she follows her (one) signal and thus votes for  $r$  if her signal is 1 (which arises with probability  $q$  when the state is  $\omega = 1$ ). If she is behavioural, she mistakenly believes that she has two independent signals. As the signals are correlated, she either observes  $(-1, -1)$  or  $(1, 1)$ . She therefore also votes for  $r$  if her signal is 1 and for  $l$

<sup>13</sup>The proof is straightforward.

otherwise and thus also follows her signal. Analogously, moderate left-wing voters would follow their signal in either case.

Consider now the more interesting case of intermediate right-wing voters in  $[v', v'']$ . A rational voter in this interval who realizes that she only has one signal, votes for  $r$  for sure as her signal is not sufficient to outweigh her political preferences. On the other hand, if she is behavioural, she votes for  $r$  with a lower probability; if her signal is  $-1$ , she believes she has received  $(-1, -1)$ , and is convinced to vote for  $l$ . She therefore votes for  $r$  only if her signal is 1 (which arises with probability  $q$  in state  $\omega = 1$ ). Thus, a behavioural voter in this interval votes less often for  $r$  compared with a rational voter. Finally, consider an intermediate left-wing voter with  $v \in [-v'', -v']$ . When the signals are correlated, such voter never votes for  $r$  when she is rational, but when behavioural, she votes for  $r$  with probability  $q$  (again, the probability that her signal is 1). Thus a behavioural intermediate left-wing voter votes more often for  $r$  compared with a rational voter.

More generally, when behavioural, each intermediate voter votes on average more in line with the state of the world rather than with the direction of her political preferences.

Therefore, in terms of vote shares for the optimal policies we should look at the relative measures of the sets of intermediate voters as well as at the accuracy of the signal,  $q$ . In what follows, let  $\lambda$  denote the relative share of the left-wing intermediate voters among all intermediate voters:

$$\lambda \equiv \frac{F(-v') - F(-v'')}{F(-v') - F(-v'') + F(v'') - F(v')}.$$

Our next result characterizes conditions on  $\lambda \in (0, 1)$  and  $q \in (0.5, 1)$  under which a behavioural electorate induces higher vote shares for the optimal policy.

**Lemma 2:** *(i) The vote share for the optimal policy in the left state ( $\omega = -1$ ) is higher in an electorate of behavioural voters ( $V_l^B(-1) > V_l^R(-1)$ ) iff  $\lambda < q$ . (ii) The vote share for the optimal policy in the right state ( $\omega = 1$ ) is higher in an electorate of behavioural voters ( $V_r^B(1) > V_r^R(1)$ ), iff  $\lambda > 1 - q$ .*

Proof: By Lemma 1 we have that  $V_r^B(1) - V_r^R(1) = \rho[q(F(-v') - F(-v'')) - (1 - q)(F(v'') - F(v'))]$  and  $V_l^B(-1) - V_l^R(-1) = \rho[q(F(v'') - F(v')) - (1 - q)(F(-v') - F(-v''))]$ . This gives (i) and (ii). ■

Note that Lemma 2 implies that if  $1 - q < \lambda < q$ , the vote share for the optimal policy is higher in a behavioural electorate in both states of the world. More generally, Lemma 2 implies that the voting behaviour of behavioural voters tends to “correct” for biases in the distribution of preferences. For example, when intermediate voters are not too left-leaning and possibly right-leaning ( $\lambda < q$ ), a behavioural electorate will induce a higher



vote share for the optimal policy in the left state (compared to a rational one). Below we illustrate how this can be translated into better information aggregation.

## 4 Information aggregation

We now flesh out the implications of Lemma 2 by focusing on information aggregation. We consider a general family of distributions of political preferences, including distributions which can be skewed to the left or to the right. We analyse information aggregation for these distributions and when there is uncertainty over which of them determines voters' preferences on election day.

For relatively symmetric distributions (that satisfy  $1-q < \lambda < q$ ), we know that the vote shares for the optimal policies are higher in both states of the world when the electorate is behavioural. For such distributions, a behavioural electorate would aggregate at least the same information as a rational electorate, and in fact, it is easy to find such distributions for which a behavioural electorate would aggregate more information than a rational electorate (that is, when for example  $V_r^B(1) > V_r^R(1) > \frac{1}{2}$  and  $V_l^B(-1) > \frac{1}{2} > V_l^R(-1)$ ).

What happens though when the distribution is not sufficiently symmetric? Suppose that  $\lambda < 1 - q$  so that the intermediate voters are right-leaning. In this case the behavioural electorate will lead to a higher vote share only in the state that goes against the bias of the electorate. That is, in  $\omega = -1$  we have that  $V_l^B(-1) > V_l^R(-1)$ , while in  $\omega = 1$ ,  $V_r^R(1) > V_r^B(1)$ . A trade-off may arise therefore between the two electorates as each yields a higher vote share for the optimal policy in a different state.

Intuition suggests though that the potential advantage of the behavioural electorate over the rational one would still be maintained even if political preferences of the whole population are biased in one direction. If the whole population is biased for example to the right, voting in the right state ( $\omega = 1$ ) should be less of an issue, as the optimal policy will be chosen at that state anyway. On the other hand, it is the left state ( $\omega = -1$ ) that becomes more problematic for information aggregation. But, in a right-leaning society, this is exactly the state in which the behavioural electorate has a comparative advantage in facilitating voting for the optimal policy.

We now formalize this intuition. We model shocks to the utility of voters as monotone likelihood ratio (MLR) shifts of the distribution of preference parameters. For distributions  $F$  and  $F'$  with densities  $f$  and  $f'$  we say that  $F' \succ_{MLR} F$  iff  $f'(v')/f'(v) \geq f(v')/f(v)$  for all  $v' > v$ . Intuitively,  $F' \succ_{MLR} F$  implies that the distribution  $F'$  puts relatively more weight on higher values, implying for example a first order stochastic shift of the distribution of preference parameters to the right.

Let the set  $\mathcal{F}$  consists of at least one symmetric distribution  $F^S$  and all the distributions  $F$  such that (i)  $F \succ_{MLR} F^S$  for some  $F^S \in \mathcal{F}$ , or (ii) there is some  $F^S \in \mathcal{F}$  such that

$F^S \succ_{MLR} F$ . Finally let  $G \in \Delta(\mathcal{F})$  denote a full support probability distribution over the set  $\mathcal{F}$ .

In what follows we assume that the distribution of preferences on the day of the election is itself distributed according to  $G$ . We evaluate information aggregation ex post as well as ex-ante, before the resolution of the draw from  $G$ . We then have:

**Proposition 1:** (i) For any  $F \in \mathcal{F}$ , a behavioural electorate aggregates the same or more information than a rational electorate and for some  $F \in \mathcal{F}$ , it aggregates more information. (ii) If  $F$  is drawn according to  $G$ , then ex-ante, a behavioural electorate aggregates more information than a rational electorate.

Proof: We will first show (i), that is, that for any  $F \in \mathcal{F}$  a behavioural electorate aggregates the same or more information than a rational electorate and that for some  $F \in \mathcal{F}$  it aggregates more information. As  $G$  is full support this will suffice to prove (ii).

Let  $F^S \in \mathcal{F}$  be a symmetric distribution. By symmetry and full support, we have that  $V_r^R(1) > \frac{1}{2}$  and  $V_l^R(-1) > \frac{1}{2}$  (as some voters vote informatively and those who do not, “cancel” each other). By Lemma 2, we then have that  $V_r^B(1) > V_r^R(1) > \frac{1}{2}$  and  $V_l^B(-1) > V_l^R(-1) > \frac{1}{2}$ . Therefore, under  $F^S$ , a behavioural electorate aggregates the same information as a rational electorate does.

We now show that for any  $F' \succ_{MLR} F^S$ , under  $F'$ , a behavioural electorate aggregates at least the same (and sometimes more) information than a rational electorate. The same arguments can be used to prove the same claim for  $F'$  such that  $F^S \succ_{MLR} F'$ .

So assume that  $F' \succ_{MLR} F^S$ . Note that  $F' \succ_{MLR} F^S$  implies that  $F'$  first order stochastically dominates  $F^S$ . As under  $F^S$  we have that  $V_r^J(1) > \frac{1}{2}$  for  $J = B, R$ , by first order stochastic dominance, a shift to  $F'$  will imply that vote shares for  $r$  only increase. Therefore, both electorates achieve the optimal outcome in  $\omega = 1$ .

Note that under  $F^S$ ,  $\lambda = \frac{1}{2} < q$ . We now show that if  $F' \succ_{MLR} F^S$  then for  $F'$ ,  $\lambda < q$ . Note that  $F' \succ_{MLR} F^S$  implies,

$$\begin{aligned} f'(v) &\geq \frac{f'(0)}{f^S(0)} f^S(v) \text{ for all } v \in [v', v''] \\ f'(v) &\leq \frac{f'(0)}{f^S(0)} f^S(v) \text{ for all } v \in [-v'', -v'] \end{aligned}$$

and hence as we shift from  $F^S$  to  $F'$ ,  $\lambda$  (weakly) decreases from a half because, given the symmetry of  $f^S$ , we have that:

$$\begin{aligned} \int_{v \in [v', v'']} f'(v) dv &\geq \frac{f'(0)}{f^S(0)} \int_{v \in [v', v'']} f^S(v) dv = \\ \frac{f'(0)}{f^S(0)} \int_{v \in [-v'', -v']} f^S(v) dv &\geq \int_{v \in [-v'', -v']} f'(v) dv, \end{aligned}$$

and hence  $\lambda \leq \frac{1}{2} < q$  for  $F'$ .

By Lemma 2, since  $\lambda < q$ , we have that, under  $F'$ ,  $V_l^B(-1) > V_l^R(-1)$ . This implies that a behavioural electorate aggregates at least the same and possibly more information than a rational electorate.

We now complete the proof by showing that there exists such  $F' \in \mathcal{F}$  under which a behavioural electorate aggregates more information than a rational electorate. We do this by finding an  $F'$  such that  $F' \succ_{MLR} F^S$  and  $V_l^B(-1) > \frac{1}{2} > V_l^R(-1)$ . Note that under  $F^S$ ,  $V_l^B(-1) > V_l^R(-1) > \frac{1}{2}$ . Also note that  $\mathcal{F}$  contains all  $F$  such that  $F \succ_{MLR} F^S$  and given Lemma 2 and the above, for all such  $F$ ,  $V_l^B(-1) > V_l^R(-1)$ . Obviously there exists  $F'' \in \mathcal{F}$  such that  $F'' \succ_{MLR} F^S$  and  $\frac{1}{2} > V_l^B(-1) > V_l^R(-1)$ . By continuity one can find  $F' \in \mathcal{F}$  such that  $F' \succ_{MLR} F^S$  and  $V_l^B(-1) > \frac{1}{2} > V_l^R(-1)$ . ■

The proof follows the intuition provided above. A shift of society to the right (to a distribution function which dominates in the MLR sense) guarantees that the optimal policy is chosen in the right-wing state under both electorates, while a behavioural electorate will outperform a rational one in the left-wing state. Continuity and full support guarantee that we can find such shifts for which a behavioural electorate will strictly outperform a rational one. Analogously, this would also be the case for a shift of society to the left (to a distribution function which is dominated in the MLR sense).

## 5 Discussion: overconfidence and confirmation bias

Correlation neglect, as noted by others (see Ortoleva and Snowberg, forthcoming, or Glaeser and Sunstein 2009), leads to overconfidence as agents become more convinced of their beliefs when they underestimate the level of the correlation of their information. Another potential source 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.

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

We maintain the same environment as in the main model. To illustrate our point in the simplest way assume that  $f(v)$  is symmetric around 0 so that  $f(v_i) = f(-v_i)$ . To model confirmation bias, we assume that the two signals a voter receives,  $s_i^1$  and  $s_i^2$ , are independent, conditional on the state. We say that an individual has *confirmation bias* (a-la Rabin and Schrag 1999), if whenever there is a conflict between the realisations of  $s_i^1$  and  $s_i^2$ , then with probability  $\rho$  the individual believes that the realisation of  $s^2$  is actually the same as  $s_i^1$ . However, when a voter is rational, he correctly recognizes the realisation

of the signal.<sup>14</sup>

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, all individuals with  $v_i \leq v''$  vote for  $r$  unless  $s_i^1 = s_i^2 = -1$ , and all individuals in  $[v'', 1]$  always vote for  $r$ . Still, when compared to rational voters, there will be no change in the vote share for the correct outcome:

**Lemma 3** *The vote shares in the model of confirmation bias are the same for both electorates, rational and behavioural.*

Proof of Lemma 3: Suppose without loss of generality that  $\omega = 1$ . Voters in  $[0, v'']$  will vote for  $r$  unless they observe two -1 signals, which happens with probability  $(1 - q)^2$  for rationals but with probability  $(1 - q)(1 - q + q\rho) > (1 - q)^2$  for behavioural. The difference is then  $q(1 - q)\rho$ . But note that voters in  $[-v'', 0]$  will vote for  $r$  only if they see two 1 signals, which happens with probability  $q^2$  for rationals and  $q(q + (1 - q)\rho) > q^2$  for behavioural. The difference in these probabilities is again  $q(1 - q)\rho$ . Therefore, if the distribution of voters is symmetric we will have the same vote shares for rational voters and for those with confirmation bias. ■

Thus, while both correlation neglect and confirmation bias induce overconfidence, modelling them explicitly -and in particular modelling the relevant information structure that allows them to arise- allows us to arrive at a different conclusion (compared with Lemma 2). This occurs because confirmation bias leads to differences in voting behaviour 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 electorate. On the other hand, with correlation neglect, the difference between behavioural and rational voters arises when the signals are correlated. 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 their -single- signal. The vote shares in a symmetric electorate would then be strictly higher for the optimal policy compared with a rational electorate.

## 6 Conclusion

The fact that voters are often misinformed is well established in the Political Science literature. This has been interpreted as a source of concern for the performances of

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<sup>14</sup>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 for confirmation bias 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.

democracies. Our paper provides a critique of this literature by pointing out that voters' misinformed and biased voting behaviour could help alleviate inherent externalities that are present in voting. In particular, the role of elections as information aggregation mechanisms is hampered by voters' tendency to vote too much according to their ideological preferences than is socially efficient. What we show is that a prevalent bias in processing information, correlation neglect, magnifies the response of voters to their own information and so, in the aggregate, can alleviate these externalities.

The paper provides several insights about the role of elections as aggregating information when voters are misinformed. First, to understand the effects of voter incompetence or misinformation on the performance of the political system, one needs to fully consider all of the externalities that are inherent in the political process when voters are competent. In this sense our critique complements the work of Ashworth and Bueno de Mesquita (forthcoming) who focus on another externality, namely the response of strategic politicians to the level of information held by the voters. Second, the particular way in which voters misuse their information is important. As we show, when voters exhibit confirmation bias rather than correlation neglect, the externalities present in voting are maintained. Therefore, it is paramount that we have a better idea of the main biases and deviations from rationality that affect voting behaviour.

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