

Information and Extremism in Elections[†]

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We model an election in which parties nominate candidates with observable policy preferences prior to a campaign that produces information about candidate quality, a characteristic independent of policy. Informative campaigns lead to greater differentiation in expected candidate quality, which undermines policy competition. In equilibrium, as campaigns become more informative, candidates become more extreme. We identify conditions under which the costs associated with extremism dominate the benefits of campaign information. Informative political campaigns increase political extremism and can decrease voter welfare. Our results have implications for media coverage, the number of debates, and campaign finance reform. (JEL D72, D83)

Democracy demands an educated and informed electorate.

— Thomas Jefferson

The purpose of a campaign is to send an intelligent and informed voter to the ballot box.

— Calvin Coolidge¹

Information about political candidates emerges during campaigns through debates, media coverage, informative advertising, and observed performance on the campaign trail. To the extent that it enables voters to make better-informed election day decisions, campaign information is generally considered to be good for democracy. Our analysis questions this widely held view. We model an election in which parties nominate candidates with observable policy preferences prior to a campaign that produces information about candidate quality, a characteristic that is orthogonal to a candidate's policy platform. A more informative campaign reduces uncertainty about candidate quality, allowing voters to make better choices on election day.

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¹The quote is from Coolidge's "Radio Address from the White House on the Duties of Citizenship," November 3, 1924. It is made available online by Gerhard Peters and John T. Woolley's "The American Presidency Project," <http://www.presidency.ucsb.edu/ws/?pid=24179>.

At the same time, an informative campaign creates quality differentiation between candidates, softening policy competition. In equilibrium, when voters receive better information about quality, the election winner simultaneously has higher expected quality and is more extreme. If the distribution of voter policy preferences is sufficiently moderate, the welfare costs associated with candidate extremism dominate the benefits. Although their voting decision is better informed, voters can become worse off as campaigns become more informative.

Past analyses considering the detrimental effects of campaigns tend to focus on the need for candidates to fundraise or seek endorsements from special interest groups, considerations that are absent from our analysis. In our framework, we show that campaigns may be detrimental even without special interest groups, fundraising, biased or private information, incumbent advantage, or turnout concerns. Campaigns serve only to produce costless, unbiased information about candidate quality that cannot be manipulated or influenced by the candidates in any way. Even under these optimistic conditions, campaign information can generate extremism and decrease voter welfare.

Our analysis considers a three-stage election. In the first stage, two political parties select candidates of uncertain quality based on their observable policy preferences. In the second stage (the campaign), additional information emerges about candidate quality, a valence trait independent of their policy preferences. In the third stage, voters elect a candidate, who then implements his preferred policy. We analyze the impact of campaign informativeness on candidate selection, policy outcomes, and voter welfare.

In an extreme case, campaigns reveal nothing new about candidate quality; voter beliefs about candidate quality are the same on election day as on the day parties nominate their candidates. Recognizing that no new information about quality will emerge, parties need to select a more moderate candidate than the other party to win election. In this case, policy competition is most fierce, and in equilibrium both parties choose candidates who will implement the policy preferred by the median voter. Compared to this, informative campaigns weaken policy competition between the parties. Parties correctly expect informative campaigns to generate *ex post* differentiation in expected candidate quality come election day. Therefore, the more extreme candidate does not necessarily lose the election, as the campaign may reveal him to be of sufficiently high expected quality to compensate for a more extreme policy platform. Thus, informative campaigns soften policy competition and decrease incentives for moderation.

The analysis identifies a trade-off between campaign information and political extremism: anticipating that better information about candidate qualities will emerge during the campaign, parties nominate more extreme candidates. If the distribution of voter policy preferences is sufficiently concentrated around the median voter, or if voters care enough about politician quality compared to policy, then increasing campaign informativeness decreases aggregate voter welfare. While the first relationship is intuitive, the second relationship is paradoxical: when voters care enough about electing high quality candidates, exposing voters to better information about candidate quality makes them worse off. When voters care primarily about candidate quality, they are less sensitive to changes in candidate policy platforms, and parties respond by

nominating more extreme candidates. In this case, the increase in extremism associated with a more informative campaign can be severe enough to dominate the potential benefit from being able to better identify which candidate is higher quality. In both sets of circumstances, the socially optimal level of campaign informativeness is neither fully uninformative nor fully informative. Rather, an intermediate level of campaign informativeness optimizes the trade-off between policy divergence and information. If informativeness exceeds the optimal level, voters are better off when they are exposed to less information about candidate quality during the campaign.

Following the initial analysis, we consider a number of extensions including nonlinear preferences, *ex ante* asymmetries between candidates, and a general information structure. We show the relationship between campaign information and extremism continues to hold in these environments. When we allow for nonlinear policy preferences, additional welfare results emerge. These results are driven by differences in the way that the costs of extremism are distributed across different segments of the electorate. For preferences sufficiently close to linear, moderate voters are most affected by changes in extremism, and the qualitative results from the main analysis continue to hold: increased information decreases voter welfare when a large enough portion of the electorate is moderate. For sufficiently concave policy preferences, extremist voters are most affected by changes in policy, and increased information decreases voter welfare when a large enough portion of the electorate prefers sufficiently extreme policies. For intermediate levels of preference concavity, neither effect dominates the informational benefit, and there does not exist a distribution of voter preferences such that increased information decreases welfare.

In Section I we discuss the relationship between our paper and existing literature. In Section II, we introduce a stylized model of political competition, which we then analyze in Sections III and IV. The initial analysis abstracts from some important considerations in order to present the main point as clearly as possible. In Section V we consider extensions. We discuss these further implications of our results in Section VI.

I. Literature

A number of analyses focus on distortions arising from candidates' attempts to influence the information generation process inherent in political campaigns by aligning themselves with special interests or elites. In Coate (2004a, b), advertising is directly informative about candidate quality but is funded by political contributions. Prat (2002a, b) considers the signaling role of campaign spending; voters make inferences about candidate quality through their ability to raise funds. In Chakraborty and Ghosh (2013), candidates may adopt policies favored by the elite in order to gain endorsements.² In these models, political candidates pander to special interest groups in order to attract the financial contributions or endorsements which are needed to convey their quality to voters during a campaign. Our results extend

²Prat (2008) provides an overview of this literature, including related papers by Ashworth (2006); Gerber (1998); and Potters, Sloof, and van Winden (1997). Alesina and Holden (2008) consider a setting in which candidates may choose to be strategically ambiguous in their announcement of policy, as they attempt to appeal to both interest groups and voters.

the insights of this literature: we show that the increased availability of accurate, exogenous information about candidate quality can generate policy divergence and decrease voter welfare even in the absence of fundraising or other motivations for candidates to pander to special interests.

A handful of recent papers consider how exposure to information about candidates' policy preferences or campaign promises may hurt voters. Crutzen, Castanheira, and Sahuguet (2010) show how political parties may be less likely to adopt competitive internal party structures when voters are more informed about policy, and this decrease in internal party competition can make voters worse off. In Eguia and Nicolo (2012), candidates can promise to provide inefficient local public goods ("pork" spending) to individual districts in an effort to win votes in those districts. They consider how the quantity of pork offered depends on voters' ability to observe candidates' promises to other districts. The analysis shows that transparency leads to greater overall pork spending. Since pork is inefficient, access to information about candidates' campaign promises can make voters worse off. Câmara and Bernhardt (2014) consider an election between an incumbent and a challenger in which voters are informed about the incumbent's past policy choices and may observe a binary signal about the challenger's policy preferences. The quality of information available about the challenger affects the incumbent's incentive to select moderate policies in the preceding period. Increasing signal informativeness shrinks the set of incumbent types that choose a moderate policy instead of their more extreme personal ideals (hurting voter welfare); at the same time it also leads the incumbents who do choose moderation to implement even more moderate policies (improving voter welfare). The analysis shows that the negative effect is first order and the positive effect is second order. Starting from a completely uninformative signal, marginally increasing informativeness always hurts the electorate. In other instances, however, more informative signals may improve voter welfare.

Our analysis is also related to a literature that considers both endogenous policy and endogenous quality (valence). Most closely related to our contribution is Carrillo and Castanheira (2008), who consider how information about candidate quality revealed during a campaign affects both policy and valence investments. The authors consider a game in which candidates first commit to publicly observable policy platforms, and then simultaneously invest to improve their quality. Voters observe policy platforms and are stochastically informed about differences in realized candidate quality. If voters never receive information about candidate quality, candidates compete only through their choice of policy; in equilibrium, candidates adopt the median voter's ideal policy. If the probability of a voter becoming informed is moderate, candidates may choose policies away from the median voter's ideal in order to commit to developing higher valence later on. In this way, more information about candidate quality can lead to policy divergence. This intuition, however, breaks down when voters are likely to become informed, in which case candidates compete strongly on *both* platform selection *and* quality investment. When voters are perfectly informed about quality, competition on both of these dimensions is most severe, simultaneously leading to complete policy moderation and maximum investment in quality, maximizing voter utility. This aspect of their results highlights a key difference between our analyses. When *ex ante* identical candidates *choose* valence, more

information incentivizes investment. This can reduce voter uncertainty about quality differences, which can result in policy moderation. In our model, fundamental quality differences between candidates exist; increasing voter information about these differences leads to quality differentiation and therefore *always* leads to extremism. In contrast to Carrillo and Castanheira (2008), we show that fully informative campaigns do not necessarily maximize voter welfare. Our framework illustrates that the resolution of uncertainty concerning candidate quality strictly *increases* (ex ante) uncertainty about the dependence of election outcomes on policy choices, generating policy divergence in equilibrium, contrasting with the branch of literature where campaigns increase (rather than reveal information about) quality.³

The main mechanism driving our results is related to probabilistic voting, where uncertainty about the policy preferences of the electorate causes policy-motivated candidates to adopt divergent platforms (e.g., Wittman 1983; Calvert 1985; Bernhardt, Duggan, and Squintani 2009). Aragones and Palfrey (2002) and Groseclose (2001) model probabilistic voting when one candidate has a known quality advantage.⁴ Herrera, Levine, and Martinelli (2008) show that both increased political polarization and increased campaign spending may result from increases in the volatility of voter preferences, which they model as aggregate shocks to voter bias in favor of one party or the other. Our framework also features party uncertainty about voter leanings on election day. However, in our analysis this uncertainty is not driven by the parties' uncertainty about voter policy preferences; rather, it arises because parties are not certain how voters will perceive their candidates' quality after additional information is revealed during the campaign. Our analysis therefore links the political extremism that arises to the level of informativeness of the campaign rather than to the distribution of policy preferences of the electorate.

The theoretical result most similar to ours is found in the industrial organization, rather than political economy, literature. Moscarini and Ottaviani (2001) show that access to prepurchase product information allows a consumer to better differentiate between competing products, which reduces the intensity of price competition between firms. They show how anti-competitive effects may dominate the information effects, and that the availability of product information may make the

³ Ashworth and de Mesquita (2009) assume that candidates commit to a policy position before choosing how much to invest in developing valence but do not analyze issues of campaign informativeness. The choice of policy position affects the incentives for subsequent valence acquisition. Ashworth and de Mesquita (2009) show that candidates may choose divergent policy positions in order to soften valence competition in the second period. Eyster and Kittsteiner (2007) consider a similar trade-off. Serra (2010) shows that with endogenous valence candidates will be high-valence or policy will be moderate, not both. Campaign spending in Herrera, Levine, and Martinelli (2008) and Meirowitz (2008) may also be interpreted as candidate investment in valence after committing to policy. Bernhardt, Câmara, and Squintani (2011) present a model of repeated elections, where voters have information about incumbent fixed valence and endogenous policy choices, but only know the party of challengers. There, higher-valence senior politicians are more likely to choose extreme policies. In another dynamic election setting, Câmara (2008) considers the interaction between politician skill, policy choice, and political advantage. He shows how even competent politicians are unlikely to choose policy that decreases their political advantage. Sahuguet and Persico (2006) also show that valence differences cause policy divergence, but assume that candidates can engage in campaign spending to increase their valence. In equilibrium, campaign spending can reduce the valence gap between the candidates leading to more moderate policy. In this case, limits to campaign spending may increase policy divergence by reducing the ability of candidates to use spending to overcome initial valence differences.

⁴ In Lind and Rohner (2011), there is uncertainty about voter opinion of candidate valence when candidates announce policy. The innovation in that model is that only some voters take into account candidate policy choices when choosing how to vote.

representative consumer worse off. We show that similar economic intuition applies in a setting of collective decision making and political elections, where more informative campaigns allow voters to better differentiate candidates, which reduces policy competition (i.e., reduces policy convergence to the median voter) and can make voters worse off. Although both models express similar economic intuition, differences in the application and research questions generate substantial differences between the frameworks. In an industrial organization setting, it is natural to assume that all consumers of a good value higher quality and lower price; in political competition, however, all voters value higher quality but *disagree* about policy. When the voters collectively elect a candidate, some voters may prefer the losing candidate. Welfare analysis is therefore significantly different in a political context. Related to this point, we also provide results concerning how the welfare consequences of informativeness depend on the distribution of voter policy preferences; no equivalent results are presented in the product information model with a single representative buyer.⁵

II. The Model

The electorate is composed of a continuum of voters. Each voter cares about both the quality of an elected politician and the policy he implements. Quality represents an attribute equally valued by all voters; for example, a high quality candidate may engage in less private rent seeking while in office, may manage resources more efficiently, may be better able to understand complex situations and react rationally under pressure, or may be better at securing earmark funding for projects in his district. Policy, ρ , is represented by a location on the real line, $\rho \in R$. We refer to a politician's preferred policy as his "ideology," denoted $\rho_j \in R$. A candidate implements his ideology if elected. Voters disagree about policy, with an individual voter's preferred policy denoted $\rho_i \in R$. We therefore refer to ρ_i as voter i 's ideology. When a politician with quality q_w and ideology ρ_w wins election, voter i receives payoff

$$u_i = \nu q_w - |\rho_w - \rho_i|,$$

where ν is the weight that voters place on quality relative to policy outcomes. The distribution of ideology in the electorate is described by cumulative distribution function $G(\rho)$, with continuous density function $g(\rho)$. The median of the distribution is normalized to be $\rho = 0$.⁶ For most of the analysis, we assume linear preferences over policy. This assumption is supported by recent empirical research showing that

⁵ Other significant differences also exist. In Moscarini and Ottaviani (2001), a single buyer can purchase at most one good, but may choose to purchase neither. In our framework, voters must elect one of the candidates, and do not have the option of electing neither candidate. While Moscarini and Ottaviani assume perfect negative correlation between the (binary) quality of the two goods, we assume that each candidate's quality is independently drawn from a continuous random variable. Thus, no strict notions of "good" and "bad" candidates exists in our framework: no matter how low a candidate's quality, there is a positive probability that his opponent is worse (and a positive probability his opponent is better).

⁶ To simplify the exposition, we also assume that this distribution has continuous support on the entire real line, and that $E[|\rho|] < \infty$.

voter behavior is consistent with “nearly linear” policy preferences (Berinsky and Lewis 2007). Section VI considers nonlinear preferences.

Two political parties, L and R , have preferred policy outcomes (or “party ideologies”) at $\rho_L^P < 0$ and $\rho_R^P > 0$. The political parties care about policy outcomes, but do not care about quality. Given that a candidate with ideology ρ_w wins election, party $j \in \{L, R\}$ receives $u_j^P = -|\rho_w - \rho_j^P|$.

In the first stage of the election, parties simultaneously choose candidates to represent the party in the election. Party $j \in \{L, R\}$ chooses the ideology of its nominee, $\rho_j \in \mathbb{R}$.⁷ Although candidate ideology is observable, both political parties and voters are uncertain about candidate quality.⁸ Parties and voters believe that any nominated candidate’s quality, denoted q_j for $j \in \{L, R\}$, is the independent realization of a normally distributed random variable: $q_j \sim N(\mu, 1)$. Thus, the candidates of both parties have the same expected quality, μ , at the time of nomination (an assumption we relax in Section VI).⁹

Following the nomination of candidates, but prior to voting, new information about candidate quality is revealed through a campaign. During the campaign, candidates engage in debates, town hall meetings, and media interviews. Voters observe how campaigns are managed, and investigative reporting may provide voters with additional details about candidate backgrounds. All of these help voters assess candidate quality. To model this process, we assume that in the second stage of the election voters observe a public signal about candidate quality. For each candidate j , voters observe a public draw s_j from a normal distribution centered around the candidate’s true quality; s_j is the realization of a random variable $S_j \sim N(q_j, \sigma_j^2)$. The higher is σ_j , the less informative is the signal about candidate j ’s quality; $\sigma_j \rightarrow \infty$ represents a perfectly uninformative signal which does not alter voters’ posterior beliefs about candidate quality. Conversely, low values of σ_j , imply that the signal is very informative about candidate quality; if $\sigma_j = 0$ the signal perfectly reveals quality.

The analysis models information revelation during a campaign as a single, independent realization of a normal random variable continuously distributed around a candidate’s true quality. A more informative campaign is modeled as a signal with

⁷ If candidates are uncertain about their qualities, then the model is equivalent to one in which candidates commit to policy platforms prior to a campaign that reveals information about quality. Alternatively, one may consider a citizen candidate model in which individuals choose whether to run for office with a policy platform equal to their ideology (e.g., Besley and Coate 1997). Without explicitly solving such a model, we expect many of the same insights to carry over from our framework. Increased campaign informativeness will increase the ex ante probability that more extreme candidates can win elections, and as a result, we expect additional equilibria to arise in a citizen candidate model in which more extreme candidates decide to run.

⁸ This is consistent with Carrillo and Castanheira (2008); Ashworth and de Mesquita (2009); and Serra (2010). Carrillo and Castanheira (2008) argue that the assumption is a good approximation for reality since there is much more uncertainty about candidate quality than about their ideology.

⁹ Our analysis is consistent with a simple candidate recruitment and vetting process in which parties choose the nominee from an interval of “qualified” candidates, (at least) one for each possible ideology in $[0, \delta_j^P]$, each of whom is known to have quality distributed according to $N(\mu, 1)$. The recruitment and vetting process of our paper does not completely resolve uncertainty about candidate quality. Furthermore, any information about candidate qualification that parties observe during nomination and vetting will also be observed by voters; thus, after the nomination stage voters and parties beliefs about candidate quality are identical. In this case, the choice of candidate ideology does not signal parties’ private information to voters. A more detailed model of the recruitment and vetting process may allow party search, private information, and signaling, and a more complex trade-off between a nominee’s expected quality and his ideology.

lower variance, σ_j . Alternatively, we could hold signal informativeness σ_j constant, and model the informativeness of a campaign as the number of signal realizations produced. For example, each debate may produce a draw from random variable $N(q_j, \sigma_j^2)$. Increasing the number of debates increases the number of draws observed by voters. In that case, a more informative campaign would be modeled by a greater number of draws from the distribution. All of our qualitative results continue to hold under this alternative specification, which is formally equivalent to ours. In Section VI, we consider a more general information structure.

In the third stage of the game, the election takes place. Because we focus on an electorate composed of a continuum of voters, no unilateral deviation by a voter can change the election outcome. However, in our setting, if there were any chance that a voter were pivotal, every voter's ballot would express his or her true preference. We therefore focus on the equilibrium in which voters cast their ballots for the candidate that they believe offers them a higher expected payoff if elected. The winner of the election is decided by majority rule.

We solve for the perfect Bayesian equilibrium strategies of the election game described above.¹⁰

In this game, nominating a candidate whose ideology is more extreme than the party ideal or is on the opposite side of the median voter is a strictly dominated strategy for parties. Party j will therefore nominate a candidate such that $0 \leq |\rho_j| \leq |\rho_j^P|$, with party L 's candidate to the left of the median ideology (zero) and party R 's candidate to the right. Define parameter $\delta_j^P \equiv |\rho_j^P|$, representing the distance between the ideology of party j and the median voter's ideology, and $\delta_j \equiv |\rho_j|$, representing the distance between candidate j 's ideology and the median voter's ideology. With this notation, δ_j corresponds to party j 's level of extremism. We make the following assumption about party ideology:

$$(a1) \quad \min \{ \delta_L^P, \delta_R^P \} > \frac{v\sqrt{\pi}}{2},$$

where π is the mathematical constant. (a1) guarantees that party ideology is always sufficiently extreme that parties choose to nominate candidates more moderate than the party ideal. Relaxing this assumption does not change the qualitative results, though it does soften them. Because parties never nominate candidates more extreme than the party ideology, the consequence of relaxing the assumption is a potentially binding upper bound on policy divergence. When the upper bound binds, additional campaign information does not increase extremism. Thus, once informativeness is sufficiently high that the cap binds, additional information only benefits voters. The range of other parameter values for which informativeness hurts voters is therefore smaller when (a1) is violated, though intermediate levels of campaign

¹⁰ Following the realization of campaign signals S_L and S_R , voters update their beliefs about candidate quality given Bayes' rule and the priors. Their equilibrium voting strategy depends on these updated beliefs. Therefore, the setting is a dynamic game of incomplete (but symmetric) information. Because of this, the appropriate solution concept is perfect Bayesian equilibria. Note, however, that because no information asymmetry exists, no signaling takes place. While a perfect Bayesian equilibrium solution formally requires the derivation of equilibrium beliefs, we generally abstract from formally stating beliefs, and focus on the equilibrium strategies.

informativeness may be optimal, even in this case. We maintain this assumption throughout the analysis.

A. Preliminaries

Focus on the Median Voter.—Voters differ only in their ideology, which is defined along a one dimensional policy space, and they share common preferences over candidate quality. On election day every voter casts a ballot for the candidate that offers him the highest expected individual payoff if elected. Therefore, if the voter at position ρ^{\wedge} is indifferent between the candidates, all voters to the right of ρ^{\wedge} vote for one of the candidates, and all voters to the left of ρ^{\wedge} vote for the other candidate. In light of this, the candidate preferred by the median voter (with $\rho_i = 0$) will win the election.¹¹

Probability of Election Win.—Candidate L defeats candidate R if he is preferred by the median voter following the campaign. That is, if

$$vE[q_L|s_L] - |\rho_L - \rho_M| > vE[q_R|s_R] - |\rho_R - \rho_M|,$$

where ρ_M is the ideology of the median voter and (s_L, s_R) represent the realizations of the campaign signals. Because $\rho_M = 0$, this condition becomes

$$(1) \quad E[q_L|s_L] - E[q_R|s_R] > \frac{\delta_L - \delta_R}{v}.$$

The left-hand side represents the difference in expected candidate quality following the campaign stage. A positive value means that candidate L has higher expected quality than candidate R . The right-hand side represents differences in ideology, and positive values mean candidate L is more extreme than candidate R . For L to win, the quality benefit he is expected to provide must dominate any policy disadvantage. Given that the campaign signals are stochastic, neither party can choose ideology to guarantee that inequality (1) holds or fails to hold. Therefore, the probability L wins election equals the probability (1) is satisfied given (δ_L, δ_R) .

It is straightforward to calculate this probability given the information structure (we present this calculation in the Appendix). Throughout, functions $\Phi(\cdot)$ and $\phi(\cdot)$, respectively, represent the cumulative distribution and probability density functions of the standard normal random variable $N(0, 1)$. The probability that each candidate wins election given (δ_L, δ_R) is

$$\Pr(j \text{ wins} | \delta_j, \delta_k) = 1 - \Phi\left(\frac{\delta_j - \delta_k}{v\alpha}\right) = \Phi\left(\frac{\delta_k - \delta_j}{v\alpha}\right),$$

where

$$\alpha \equiv \sqrt{\frac{1}{1 + \sigma_L^2} + \frac{1}{1 + \sigma_R^2}}.$$

¹¹ If the median voter is indifferent between the two candidates, each wins with equal probability. This can happen in equilibrium only when $\sigma_L = \sigma_R \rightarrow \infty$.

Parameter α is a measure of the overall level of campaign informativeness. It depends only on the standard deviation of the campaign signals, σ_L and σ_R , and is strictly increasing as voters observe more accurate signals about either candidate's quality (i.e., as either σ_j decreases). When both campaigns are fully informative (i.e., when $\sigma_L = \sigma_R = 0$), α takes on its maximum value at $\alpha = \sqrt{2}$. When both campaigns are fully uninformative (i.e., when $\sigma_L = \sigma_R \rightarrow \infty$), α takes on its minimum value at $\alpha = 0$. Party j 's probability of winning is decreasing in its own level of extremism and increasing in its opponent's level of extremism.

III. Effects of Campaigns on Candidate Ideology

In this section, we present our first main result: more informative campaigns result in the nomination of more extreme candidates. In equilibrium, party j 's chosen level of extremism, δ_j , must maximize its expected payoff given the other party's δ_k . The expected payoff to party j given policy divergences (δ_j, δ_k) is

$$\begin{aligned} (2) \quad E[u_j^P(\delta_j, \delta_k)] &= -|\delta_j^P - \delta_j| \Phi\left(\frac{\delta_k - \delta_j}{v\alpha}\right) - |\delta_j^P + \delta_k| \left(1 - \Phi\left(\frac{\delta_k - \delta_j}{v\alpha}\right)\right) \\ &= -\delta_j^P + \Phi\left(\frac{\delta_k - \delta_j}{v\alpha}\right) \delta_j - \left(1 - \Phi\left(\frac{\delta_k - \delta_j}{v\alpha}\right)\right) \delta_k \\ &= -\delta_j^P - \delta_k + \Phi\left(\frac{\delta_k - \delta_j}{v\alpha}\right) (\delta_j + \delta_k). \end{aligned}$$

The derivative of this function is given by the following:

$$\frac{\partial E[u_j^P(\delta_j, \delta_k)]}{\partial \delta_j} = \Phi\left(\frac{\delta_k - \delta_j}{v\alpha}\right) - (\delta_j + \delta_k) \phi\left(\frac{\delta_k - \delta_j}{v\alpha}\right) \frac{1}{v\alpha}.$$

This expression illustrates the trade-off inherent in a party's choice of ideology. If the party nominates a marginally more extreme candidate, then it experiences a marginal policy benefit whenever its candidate wins election. This benefit is reflected in the first term. However, nominating a more extreme candidate also reduces the probability the party wins the election, a cost reflected in the second term.

In equilibrium, each party chooses a level of extremism δ_j in which the marginal benefits of nominating a more or less extreme candidate equal the marginal costs of doing so, given the equilibrium nomination strategy of the other party. The first lemma summarizes the unique equilibrium policy choice.

LEMMA 1 (Equilibrium Extremism): *In the unique equilibrium of the election game, the two parties nominate equally extreme candidates: $\delta_L = \delta_R = \delta^*$, where*

$$\delta^* \equiv \frac{v\sqrt{2\pi}}{4} \alpha.$$

The higher is δ^* , the more divergent are the ideologies of both candidates, and the more extreme they are compared to the preferences of the median voter.

Unsurprisingly, equilibrium policy divergence δ^* is increasing in v . Higher v means voters care less about candidate ideology relative to candidate quality. Thus, when v is high the marginal cost of increasing extremism (in terms of a reduction in the probability of being elected) is smaller, leading to greater policy extremism in equilibrium.

Our first main result describes the relationship between equilibrium extremism and campaign informativeness: δ^* is strictly increasing in α . The more informative are campaigns, the more divergent are the ideologies of the nominated candidates.

PROPOSITION 1 (Informativeness and Extremism):

- *In equilibrium, when either campaign becomes more informative, both parties nominate candidates with more extreme ideology.*
- *Candidate ideology converges to the median voter only when both campaigns are completely uninformative.*

When both campaigns are completely uninformative, the candidates remain indistinguishable on the quality dimension following the campaign. In this case, the more moderate candidate always wins, and party competition to nominate the more moderate candidate results in nominees who share the same ideology as the median voter. On the other hand, when campaigns reveal information about candidate quality, then the more moderate candidate is not guaranteed to win the election. The parties recognize that campaigns will expose differences in expected candidate quality, and that a more extreme candidate may still win election if the campaign reveals him to be of sufficiently high expected quality to overcome his policy disadvantage. Parties react to the anticipated revelation of information about quality by nominating more extreme candidates in the first stage. Thus, in equilibrium, informative campaigns undermine the incentive for parties to moderate the ideology of their nominees, resulting in greater policy extremism in equilibrium.

IV. Voter Welfare

Since more informative campaigns result in both better informed voters and more extreme candidates, it is not initially clear whether voters benefit from more information. Continuing the analysis from the previous section, we show that the downsides of more information may dominate its benefits, and voters may be worse off when campaigns are more informative.

Total voter welfare is measured as the utilitarian sum of voter payoffs. Given that a politician with ideology ρ_w and quality q_w wins election, welfare equals

$$W(\rho_w, q_w) = vq_w - L(\rho_w),$$

where

$$L(\rho_w) = \int_{-\infty}^{\infty} g(\rho_i) |\rho_w - \rho_i| d\rho_i$$

is the average voter utility loss due to divergence between an election winner's ideology and the preferred ideologies of the individual voters. The expression for $L(\rho_w)$ may be rewritten

$$L(\rho_w) = (2G(\rho_w) - 1)\rho_w - \int_{-\infty}^{\rho_w} g(\rho_i)\rho_i d\rho_i + \int_{\rho_w}^{\infty} g(\rho_i)\rho_i d\rho_i.$$

Therefore,

$$(3) \quad \frac{\partial L(\rho_w)}{\partial \rho_w} = 2G(\rho_w) - 1.$$

As is evident from equation (3), the voter welfare loss associated with election winner ideology is minimized when $G(\rho_w) = \frac{1}{2}$. That is, when the election winner ideology equals that of the median voter, $\rho_w = \rho_M = 0$. As the distance between ρ_w and $\rho_M = 0$ increases, the welfare loss associated with winner ideology increases.

Although the welfare cost of extremism is smallest when candidates share the ideology of the median voter, such candidates are only nominated in equilibrium if campaigns are completely uninformative. Whenever $\alpha > 0$, candidate ideology diverges from the median voter's ideology, with this distance increasing as either campaign becomes more informative. Therefore, the policy divergence caused by informative campaigns imposes a cost on voters.

At the same time that an informative campaign causes divergence in candidate ideology, damaging voter welfare, it also results in voters being more informed about candidate quality, reducing uncertainty, and improving voter welfare. Because in equilibrium both parties choose equally extreme candidates, i.e., $\delta_R = \delta_L = \delta^*$, in equilibrium voters elect the candidate who has the higher expected quality following the realization of the campaign signals. The election winner is the candidate whose posterior quality distribution has the higher mean. When campaign informativeness is α the expected quality of the election winner simplifies to the following (see the calculation in the Appendix):

$$E[q_w] = \mu + \frac{\alpha}{\sqrt{2\pi}}.$$

The expected quality of the election winner is strictly increasing in overall campaign informativeness, α , and is therefore also increasing in the informativeness of the individual campaigns.

Increases in campaign informativeness, therefore, have two confounding effects: the expected quality of the election winner increases, benefiting voters, and parties nominate candidates with more extreme ideologies, hurting voters. To understand the interaction of these effects, we write expected aggregate equilibrium welfare as a function of α :

$$EW(\alpha) = v\left(\mu + \frac{\alpha}{\sqrt{2\pi}}\right) - \frac{1}{2}(L(\delta^*) + L(-\delta^*)),$$

where δ^* depends on α . Expected voter welfare is decreasing in α if and only if

$$(4) \quad G(\delta^*) - G(-\delta^*) \geq \frac{2}{\pi},$$

and increasing in α if and only if (4) holds with the opposite inequality. The inequality says that more informative campaigns decrease voter welfare when a sufficient portion of the electorate has more moderate ideology than the candidates who are nominated in equilibrium. This result is quite intuitive. While a small enough increase in campaign informativeness increases extremism, the increased extremism does not impose a welfare cost on a voter with ideology outside of the interval $(-\delta^*, \delta^*)$. While one candidate moves away from the voter's ideology, the other candidate moves closer to it. Because each candidate is equally likely to win election in equilibrium, these effects offset. Thus voters with relatively extreme ideologies only benefit from increased campaign informativeness, as it allows them to select higher quality candidates. However, voters with ideology inside $[-\delta^*, \delta^*]$ are "doubly" hurt by an increase in extremism, as the ideology of each candidate moves away from these voters' preferred positions. If the mass of voters in this interval is relatively high, then the welfare cost of extremism on moderate voters dominates the informational benefits for all voters.

Because of the confounding effects, the relationship between campaign informativeness and voter welfare may be nonmonotonic. At $\alpha = 0$, both candidates moderate perfectly, $\delta^* = 0$, so condition (4) fails to hold; starting from an uninformative campaign, a marginal increase in informativeness always improves the welfare of the electorate. Fully-informative campaigns, $\alpha = \sqrt{2}$ satisfy condition (4) provided

$$(5) \quad G\left(\frac{v\sqrt{\pi}}{2}\right) - G\left(-\frac{v\sqrt{\pi}}{2}\right) > \frac{2}{\pi}.$$

Whenever condition (5) holds, an interior value $\tilde{\alpha} \in (0, \sqrt{2})$ satisfies inequality (4) with equality. For all $\alpha > \tilde{\alpha}$, inequality (4) holds with strict inequality, and increases in campaign informativeness reduce electorate welfare; for $\alpha < \tilde{\alpha}$, increases in campaign informativeness increase electorate welfare. These observations bring us to the second proposition.

PROPOSITION 2 (Informativeness and Voter Welfare): *If (i) voters put sufficient value on politician quality (v is sufficiently high) or (ii) the distribution of voter preferences is sufficiently concentrated around the median voter, then a threshold $\tilde{\alpha} \in (0, \sqrt{2})$ exists, such that voter welfare is strictly increasing in campaign informativeness for $\alpha < \tilde{\alpha}$ and is strictly decreasing in campaign informativeness for $\alpha > \tilde{\alpha}$.*

When either condition in Proposition 2 is satisfied, voter welfare is maximized when campaigns are less-than-fully informative. Otherwise, fully informative campaigns are optimal. The two conditions stated in the proposition are consequences

of (5). Observe that (5) will certainly hold whenever v , the parameter representing how much voters care about quality, is large enough, resulting in case (i) of the proposition. The more importance voters ascribe to politician quality relative to ideology, the less a candidate's probability of winning depends on his or her ideology. Parties respond by nominating candidates with more extreme ideologies. Thus, for any α , a larger v means that a larger portion of the population is more moderate than the candidates. Thus larger v increases the left-hand side of (5), and a sufficiently large v always ensures that the equation is satisfied. Condition (ii) refers to how "condensed" the distribution of voter ideology is around the ideology of the median voter. The more condensed the distribution of voter ideology is around the median, the larger is $G(\delta^*) - G(-\delta^*)$. If voter ideology is normally distributed, for example, then a lower-variance distribution corresponds to a larger share of the population with more moderate ideology than the candidates. In this case, candidate extremism imposes a welfare cost on a larger portion of the electorate; if enough voters bear this cost, overall welfare is hurt.

An interesting related result involves the relationship between the welfare maximizing level of campaign informativeness and v , the parameter representing how much voters care about politician qualifications.

PROPOSITION 3: *If voter welfare is maximized by less-than-fully informative campaigns, then the welfare maximizing level of campaign informativeness is decreasing in v .*

The result is paradoxical. When voters care more about electing high quality candidates, they are better off when the campaign reveals less about candidate quality. As the intensity of voter preferences for quality increases, the optimal level of campaign informativeness decreases, even though less informative campaigns make it less likely that voters elect the higher quality candidate. This is because any increase in α has a larger impact on δ^* when v is high compared to when v is low. Higher v means candidate ideology is more sensitive to changes in campaign informativeness. As a result, the welfare-maximizing level of campaign informativeness decreases as v increases.¹²

V. Alternative Assumptions

The above analysis relies on a stylized model which focuses on developing intuition for our main result and highlighting our contribution to the literature. As always, a variety of alternative assumptions may have been used. Here, we discuss three of the more interesting alternatives in an effort to further develop intuition regarding which assumptions are responsible for our results.

¹² It is important to point out that this result is true for increases in v that do not violate (a1), which we assume throughout.

A. Concave Policy Preferences

In Sections II, III, and IV we focus on linear policy preferences for voters: when a candidate who does not share her ideology is elected, the voter's loss (on the policy dimension) is the absolute value of the difference between her and the candidate's ideal points. This preference structure is analytically convenient; it is also consistent with recent empirical research showing that voter behavior is best explained by "nearly linear" policy preferences (Berinsky and Lewis 2007). However, because a strictly concave policy preference is often encountered in the literature, in this section we incorporate this feature into the analysis.

Imagine that a voter's loss from the policy difference between him and the winning candidate is equal to the absolute value of the difference in ideologies, raised to power $\beta > 1$. In this case, when a candidate of quality q_w and ideology ρ_w wins election, the payoff of a voter with ideology ρ_i is equal to the following:

$$u_i = vq_w - |\rho_w - \rho_i|^\beta.$$

Parameter $\beta > 1$ represents the degree of concavity of voter preferences. Party preferences are linear, as in Section II.¹³ To simplify the exposition in this section, we focus on an electorate with normally distributed ideology, $\rho_i \sim N(0, s^2)$, though the results in the Appendix apply more broadly. The following proposition summarizes the results.

PROPOSITION 4 (Information and Extremism with Nonlinear Preferences): *For any $\beta > 1$, parties nominate candidates of identical extremism, and the extremism of both candidates increases as either campaign becomes more informative. The impact of campaign informativeness on social welfare depends on β :*

- *When $\beta < \pi/2$, an increase in campaign informativeness decreases voter welfare if and only if the electorate is sufficiently moderate (the variance of voter preferences, s^2 , is sufficiently small).*
- *When $\pi/2 \leq \beta \leq 2$, there does not exist a distribution of voter preferences such that increased campaign informativeness decreases voter welfare.*
- *When $\beta > 2$, an increase in campaign informativeness decreases voter welfare if and only if the electorate is sufficiently extreme (the variance of voter preferences, s^2 , is sufficiently large).*

This proposition extends the result of Proposition 1 to the current setting, as in the linear case, information arriving during the campaign weakens the connection between a candidate's ideology and the probability of election win. Competition over policy is softened, generating equilibrium extremism.

¹³ Although the body of the paper focuses on voter preference concavity, the Appendix also extends our results to the case of quadratic party preferences, showing that an electorate sufficiently concentrated around the median voter is hurt by increases in campaign informativeness.

With concave voter preferences, the results for voter welfare are more subtle. To understand these results, consider the way that a marginal increase in extremism affects voters with different policy preferences. Imagine that the level of extremism of both candidates is δ . Because candidates are symmetric, each is equally likely to win election; from the perspective of a voter, the election can be viewed as a fair lottery over ideologies $\{\delta, -\delta\}$. Whenever $\beta > 1$, an increase in candidates' extremism hurts the welfare of all voters in the electorate. As in the case of $\beta = 1$, voters who are more moderate than the candidates, $|\rho_i| < \delta$, are hurt because both candidates move further away from the voters' ideal points. Unlike the case of $\beta = 1$, voters who are more *extreme* than the candidates, $|\rho_i| > \delta$, are also hurt by an increase in extremism: while their preferred candidate moves closer to their ideal point the opposing candidate moves further away. For $\beta = 1$ these two effects completely offset; for $\beta > 1$, however, the loss imposed by the opposing candidate moving away dominates the gain generated by the preferred candidate moving closer, resulting in a net loss of welfare.

While all voters are hurt by an increase in extremism, some voters may be hurt more than others. For $\beta < 2$, the damage associated with a marginal increase in extremism is decreasing in $|\rho|$. Therefore, a voter with moderate ideology (a smaller value of $|\rho|$) suffers more from a marginal increase in extremism than a voter with extreme ideology (a larger value of $|\rho|$). In these cases increases in candidate extremism are most damaging to voter welfare when a large portion of the electorate has ideology close to the median. For $\beta > 2$, the damage associated with a marginal increase in extremism is increasing in $|\rho|$, and is unbounded as $|\rho| \rightarrow \infty$. In these cases increases in extremism are most damaging to the welfare of the electorate when a large portion of voters has *extreme* ideologies. When $\beta = 2$ the marginal impact of increased extremism is identical for every voter in the electorate.

These observations provide insight into the welfare results of Proposition 4. For both the first and second parts of this proposition, a moderate electorate is most damaged by increased extremism. If equilibrium extremism grows quickly as overall campaign informativeness increases, the welfare of the moderate part of the electorate will be sufficiently damaged by the increase in extremism to dominate the benefits of additional information. This effect arises when voter preferences are "close to linear," $1 < \beta < \pi/2$. When voter preferences are more concave, $\pi/2 < \beta \leq 2$, extremism does not grow quickly enough as informativeness increases to damage the electorate in aggregate. When $\beta > 2$, however, voters with ideologies in the tails of the distribution are most damaged by marginal increases in candidate extremism, and this damage grows without bound as the voter's ideology becomes more extreme. In this case, the damage to total welfare can be arbitrarily large, provided that a sufficient portion of the electorate has ideologies in the tails of the distribution. If the normal distribution of voter preferences has a large variance, the welfare cost of policy extremism dominates the benefits.

B. Asymmetric Expected Quality

Our analysis focuses on the case in which parties and their potential pool of candidates are *ex ante* undifferentiated: the initial expected quality of the candidate

nominated by either party is identical. This is a natural assumption, and we see no reason that the distribution of candidate quality should differ by party. Under an alternative interpretation of our model, however, the parties are actually two competing, policy-motivated candidates on opposite sides of the median voter who commit to their own policy platforms at the beginning of their campaigns. In this case, it is perfectly reasonable to assume that the two candidates have *ex ante* differences in expected quality.

In the Appendix, we show that the results extend in a natural way when the difference in expected candidate quality is not too pronounced. In equilibrium, the party whose candidate is expected to be higher quality capitalizes on its advantage by nominating a more extreme candidate than in the symmetric equilibrium, and the initially disadvantaged party chooses a more moderate ideology. When the difference in prior qualities is not too large, even the (moderately) disadvantaged party does not converge to the ideology of the median voter. Just as in the symmetric case, if the distribution of voter tastes is sufficiently concentrated about the median, then increasing the informativeness of campaign signals decreases aggregate voter welfare.

C. General Information Structure

Throughout the paper, we assume that candidate quality is distributed according to $N(\mu, 1)$, and that voters observe realizations of informative signals distributed around the candidates' true quality according to $N(q_j, \sigma_j^2)$. The use of normal distributions is helpful for the analysis, as it allows us to clearly formulate a measure of overall campaign informativeness, α , and to maintain tractability through the analysis of policy outcomes and voter welfare. In this section, we revisit the link between campaign informativeness and extremism in a more general information structure.

Imagine an information structure in which candidate qualities are distributed according to identical prior distributions, and campaigns generate realizations of signals S_L and S_R , random variables whose distributions are conditional on candidate quality. In this case, a realization of S_j , denoted s_j , would (in equilibrium) convey information to voters about candidate quality, causing voters to update their prior distribution to a posterior distribution. Given signal realization s_j , the expected quality of candidate j is just the mean of the posterior distribution, $E(q_j|s_j)$. Because s_j is random, before it is realized (at the nomination stage) this posterior mean is itself a random variable $E(q_j|S_j)$. The difference of posterior means $E(q_L|S_L) - E(q_R|S_R)$ is therefore also a random variable \hat{Q} , which we sometimes refer to as the *posterior mean quality difference*, or just the *quality difference*. Throughout, we assume that random variable \hat{Q} is distributed according to differentiable cumulative distribution function $H(\cdot)$, with associated density $h(\cdot)$ supported on an interval I , or on the real line. In this section, we also maintain the following assumptions about this random variable:

- (a2) \hat{Q} is symmetric: $h(-x) = h(x)$, or equivalently, $1 - H(x) = H(-x)$, for any $x \in I$.
- (a3) The reverse hazard rate $h(x)/H(x)$ is strictly decreasing for $x \in I$.

(a2) rules out biases in the information generation process which may favor one candidate over another. Note that the assumption of identical priors for q_L and q_R guarantees that the expected posterior mean quality difference is zero, $E[\hat{Q}] = 0$; however, this alone is not enough to ensure neutrality in information production. For example, if we imagine that voters learn about candidate quality from a single political debate, a biased moderator could potentially ask questions or format the debate in a way that affects the shape (for example, the skew) of the distribution of the quality difference, while maintaining a mean of zero. A moderator sympathetic to party L could manipulate the debate to generate a quality difference random variable with a negative median and a zero mean, guaranteeing that $H(0) > 1/2$. In this case, the posterior mean quality difference is more likely to be positive than negative, and candidate L is more likely to emerge from the debate with a higher expected quality. Extending this idea, the biased moderator could ensure that the posterior mean quality difference favors L by at least specified level $d > 0$ with higher probability than it favors party R :

$$\Pr(\hat{Q} \geq d) > \Pr(\hat{Q} \leq -d) \Leftrightarrow 1 - H(d) > H(-d).$$

(a2) rules out this type of manipulation, requiring that the probability that the quality difference favors L by at least d is identical to the probability that the quality difference favors party R by at least d : $1 - H(d) = H(-d)$.

(a3) requires that the cumulative distribution function $H(\cdot)$ is log-concave.¹⁴ In the analysis, (a3) is connected to second order conditions of the parties' problem, guaranteeing that if a stationary point of the party payoff function exists, it is a unique global maximum.

As in Section II, we introduce an assumption on party ideology that ensures that equilibrium candidate ideology is less extreme than the party ideal, an analogue of (a1).

$$(a1') \quad \min \{ \delta_L^P, \delta_R^P \} > \frac{v}{4h(0)}.$$

As in the previous section, if this assumption is violated, parties may nominate candidates that share their own ideology, the highest extremism that could arise in equilibrium. We are now ready to state the first result of this section, which characterizes equilibrium extremism in the extended model.

LEMMA 2 (Equilibrium Extremism, General Structure): *Under (a1'), (a2), and (a3), a unique equilibrium exists. The equilibrium is symmetric, $\delta_L = \delta_R = \bar{\delta}$, where*

$$\bar{\delta} \equiv \frac{v}{4h(0)}.$$

¹⁴ For information on log-concavity, see Bagnoli and Bergstrom (2005).

Lemma 2 is a direct generalization of Lemma 1, characterizing the unique equilibrium level of ideological extremism in the extended model. In order to use Lemma 2 to analyze the link between the accuracy of campaign information and ideological extremism, we use the rotation order of Johnson and Myatt (2006) to rank the informativeness associated with campaign signals.¹⁵

Rotation Order: *Function $F_a(\cdot)$ is flatter in the rotation order than function $F_b(\cdot)$ on interval $[\underline{x}, \bar{x}]$ if there exists a rotation point $x^\dagger \in [\underline{x}, \bar{x}]$ such that*

$$\begin{aligned} \forall x \in [\underline{x}, \bar{x}], \quad x > x^\dagger &\Leftrightarrow F_b(x) > F_a(x) \\ x = x^\dagger &\Leftrightarrow F_b(x) = F_a(x) \\ x < x^\dagger &\Leftrightarrow F_b(x) < F_a(x). \end{aligned}$$

Ranking in the rotation order is a single-crossing condition, guaranteeing that the ranked functions cross only once over the interval, at the point of rotation. The rotation order also implies a relationship between the derivatives at the point of rotation: if $F_a(\cdot)$ is flatter in the rotation order than $F_b(\cdot)$, then $F'_a(x^\dagger) \leq F'_b(x^\dagger)$. These could, however, be equal.

Strong Rotation Order: *If function $F_a(\cdot)$ is flatter than $F_b(\cdot)$ in the rotation order on $[\underline{x}, \bar{x}]$, with rotation point x^\dagger , then $F_a(\cdot)$ is flatter in the strong rotation order whenever $F'_a(x^\dagger) < F'_b(x^\dagger)$.*

Next, we use the rotation order to rank the precision of campaign signals, using the approach of Ganuza and Penalva (2010). For the rest of this section of the paper, consider a pair of posterior mean quality difference random variables, $\{\hat{Q}_i\}$ for $i \in \{\alpha, \beta\}$, satisfying assumptions (a2) and (a3), each with differentiable distribution function $H_i(\cdot)$ and associated density $h_i(\cdot)$, defined over supports $I_i \equiv [q_i, \bar{q}_i]$. The signal structure generating posterior mean quality difference random variable \hat{Q}_i is referred to as signal structure i .

(Strong) RO-precision: *Signal structure α is (strongly) more RO-precise than signal structure β if cumulative distribution function $H_\alpha(\cdot)$ is flatter than $H_\beta(\cdot)$ in the (strong) rotation order on I_b .*

If signal structures can be ranked by RO-precision, (a2) guarantees that the rotation point must be zero. Furthermore, because $E[\hat{Q}_\alpha] = E[\hat{Q}_\beta] = 0$, ranking signal structures in the rotation order implies a ranking of posterior mean random variables by second order stochastic dominance.¹⁶ Specifically, if signal structure α is more RO-precise than β , then \hat{Q}_β second order stochastically dominates \hat{Q}_α . This relationship between RO-precision and second order stochastic dominance allows us to apply the

¹⁵ A similar construction to the one we use appears in Shi (2012); Ivanov (2013); and Ganuza and Penalva (2007).

¹⁶ This is simple to see using the integral condition for second order stochastic dominance. See also Shi (2012).

integral precision criterion of Ganuza and Penalva (2010). The intuitive idea of this precision criterion is that “if the informational content of a signal is low, conditional expectations are concentrated around the expected value of the prior. When the informational content is high, conditional expectations depend, to a large extent, on the realization of the signal, which increases their variability.”¹⁷ Applied to our setting, this criterion states that signal structure α has greater integral precision than signal structure β if and only if \hat{Q}_β second order stochastic dominates \hat{Q}_α —in this formal sense \hat{Q}_α has greater “variability” than \hat{Q}_β . Therefore, an RO-precision ranking implies a ranking by integral precision.

In Section III we established that in the standard normal information structure, reductions in the variance of campaign signals introduce two competing effects: they increase the expected quality of the election winner and increase the equilibrium level of ideological extremism. The next proposition demonstrates that a similar trade-off arises in the more general framework of this section.

PROPOSITION 5 (Information and Extremism, General): *Consider signal structures α , β , such that \hat{Q}_α and \hat{Q}_β satisfy the assumptions of this section of the paper, and assume (a1'). If signal structure α is more RO-precise than signal structure β then*

- *The equilibrium expected quality of the election winner is strictly higher with signal structure α than with signal structure β .*
- *Equilibrium extremism is at least as high with signal structure α as with signal structure β . Equilibrium extremism is strictly higher whenever α is strongly more RO-precise.*

Thus, an increase in (strong) RO-precision of the signal structure leads voters to make better-informed election day decisions, increasing the expected quality of the election winner; at the same time, it (strictly) weakly increases the ideological extremism of nominated candidates. Thus, the central trade-off associated with increases in campaign signal informativeness is also relevant in the extended model.

VI. Conclusions

The paper's contribution centers around two main results. First, we show that as campaigns become more informative about candidate quality, parties nominate more extreme candidates. The additional information about candidate quality that arrives during a campaign weakens the link between a candidate's ideology and his election chances, softening the incentive to moderate policy platforms. More informative campaigns lead to elected officials being both higher expected quality and more extreme. Second, we show that, from an ex ante perspective, the expected costs of campaign informativeness may dominate the benefits: although increasing informativeness supplies voters with better information about realized candidate quality, the increase in

¹⁷ See, Ganuza and Penalva (2010, 1008).

candidate extremism dominates this advantage. Consequently, if the distribution of voter preferences is sufficiently concentrated around the median voter, the *ex ante* welfare maximizing campaign signal is less than fully informative about quality. When the electorate is sufficiently extreme, fully informative campaigns are best. Completely uninformative campaigns are never optimal, despite the perfect moderation that arises.

The results suggest that seemingly beneficial increases in the number of debates or expanded media coverage may have unintended welfare consequences. Our results also offer a novel contribution to the debate regarding campaign finance reform. Political contribution limits and campaign spending caps are often viewed by supporters as a means of reducing politician reliance on private money for running campaigns, mitigating distortions in the political process. Opponents argue that these limits potentially reduce voter exposure to information, which—according to the conventional wisdom—hurts voter welfare. Our analysis suggests that exposure to less information may not be as detrimental to voters as intuition suggests. Although it leads to a less informed electorate, it also encourages policy moderation. The benefits of policy moderation may be dominant, leaving voters better off. Contribution limits and spending caps may benefit voters precisely *because* they reduce information.

In our model, campaigns provide information about quality. If the campaigns alternatively produced information about candidate ideology, then additional information may lead to the equilibrium selection of less extreme candidates. More information leads to increased extremism only in as much as it reduces uncertainty about a candidate characteristic orthogonal to ideology. Additionally, our analysis treats campaign informativeness as exogenous, and does not model the politics behind candidate nomination. One could imagine a model of endogenous campaign informativeness in which parties select campaign informativeness directly, or one in which campaign informativeness is determined by a strategic media, in response to party actions. We leave these interesting considerations to future research.

Political polarization has risen substantially in America since the early 1970s (McCarty, Poole, and Rosenthal 2006). In a recent telephone poll conducted by *USA Today* and the Bipartisan Policy Center (February 2013), the majority of Americans agree that “American politics has become more divided in recent years” because “both parties have changed: Democrats [have become] more liberal and Republicans more conservative,” and that this “deeper division is a bad thing.”¹⁸ Our analysis establishes a link between increases in voter information and increases in the extremism of political candidates and elected officials. We do not claim that change in voter information is the only relevant factor driving increased polarization. We do show, however, that changes in voter exposure to information (through changes in media coverage, the Internet, and debate formats) may have important implications for candidate extremism, which could contribute to political polarization more generally. A detailed empirical study may give better insight into the relative importance of this effect.

¹⁸ See “Political Partisanship Mirrors Public,” *USA Today*, March 6, 2013, <http://usat.ly/WtxQie>. It is interesting to note that the majority believes that “the divisions between the political parties in Washington doesn’t mean there are deep divisions among everyday Americans.” This suggests that the increased division in Washington is not driven by increased division amongst the electorate, but may be driven by other factors.

MATHEMATICAL APPENDIX

PROOF OF LEMMA 1:

The body of the paper establishes that candidate L wins election if following the realization of campaign signals s_L and s_R , inequality (1) in the body of the paper [i.e., $E[q_L|s_L] - E[q_R|s_R] > (\delta_L - \delta_R)/v$] is satisfied. Each party chooses its respective δ_j to maximize the probability it wins the election given the choice of δ_k by the other party. We must therefore determine the probability (1) is satisfied given any choice of δ_L and δ_R .

First consider $E[q_j|s_j]$. Given that $q_j \sim N(\mu, 1)$ and $S_j|q_j \sim N(q_j, \sigma_j^2)$, the posterior belief regarding q_j given a particular signal realization s_j is as follows:

$$q_j|S_j = s_j \sim N\left(\frac{s_j + \mu\sigma_j^2}{1 + \sigma_j^2}, \frac{\sigma_j^2}{1 + \sigma_j^2}\right).$$

Therefore, expected candidate quality given signal realization s_i is just the mean of this distribution.

$$E[q_j|s_j] = \frac{s_j + \mu\sigma_j^2}{1 + \sigma_j^2},$$

and $E[q_L|s_L] - E[q_R|s_R] > (\delta_L - \delta_R)/v$ may be rewritten

$$(A1) \quad \frac{s_L + \mu\sigma_L^2}{1 + \sigma_L^2} - \frac{s_R + \mu\sigma_R^2}{1 + \sigma_R^2} > \frac{\delta_L - \delta_R}{v}.$$

Given the information structure, it is simple to calculate the unconditional distribution of the campaign signal S_j .

$$q_j \sim N(\mu, 1) \quad \text{and} \quad S_j|q_j \sim N(q_j, \sigma_j^2) \Rightarrow S_j \sim N(\mu, 1 + \sigma_j^2).$$

We use this to find the distribution of the posterior mean of candidate quality:

$$S_j \sim N(\mu, 1 + \sigma_j^2) \Rightarrow \frac{S_j + \mu\sigma_j^2}{1 + \sigma_j^2} \sim N\left(\mu, \frac{1}{1 + \sigma_j^2}\right).$$

From here we find the distribution of the left-hand side of (A1):

$$\frac{s_L + \mu\sigma_L^2}{1 + \sigma_L^2} - \frac{s_R + \mu\sigma_R^2}{1 + \sigma_R^2} \sim N(0, \alpha^2),$$

where

$$\alpha \equiv \sqrt{\frac{1}{1 + \sigma_L^2} + \frac{1}{1 + \sigma_R^2}}.$$

Therefore, if $\Phi(\cdot)$ is the cdf of the $N(0, 1)$ distribution, then $E[q_L|s_L] - E[q_R|s_R] > (\delta_L - \delta_R)/v$ is satisfied with probability $\Phi((\delta_L - \delta_R)/(v\alpha))$.

This means that the expected payoff to party j given δ_j, δ_k is given by (2) in the body of the paper. The derivative of party j 's expected utility with respect to δ_j is

$$\frac{\partial Eu_j^P}{\partial \delta_j} = \Phi\left(\frac{\delta_k - \delta_j}{\alpha v}\right) - (\delta_j + \delta_k)\phi\left(\frac{\delta_k - \delta_j}{\alpha v}\right)\frac{1}{\alpha v}.$$

This expression implies the following condition:

$$(A2) \quad \frac{\partial Eu_j^P}{\partial \delta_j} > 0 \Leftrightarrow \frac{\phi\left(\frac{\delta_k - \delta_j}{\alpha v}\right)}{\Phi\left(\frac{\delta_k - \delta_j}{\alpha v}\right)} < \frac{\alpha v}{\delta_k + \delta_j}.$$

Because the normal CDF is log-concave (Bagnoli and Bergstrom 2005), function $\phi(\cdot)/\Phi(\cdot)$ is decreasing. Meanwhile, the argument of this function $(\delta_k - \delta_j)/(\alpha v)$ is decreasing in δ_j . Hence, the left-hand side of the inequality in (A2) is a strictly increasing function of δ_j . The right-hand side of the inequality in (A2) is strictly decreasing in δ_j . Thus, for any value of δ_k , (A2) can hold as an equality for at most one value of δ_j : at most one critical point of the party payoff function exists. Furthermore, if (A2) does hold with equality for some value of δ_j , it must be that the function on the left-hand side of (A2) intersects the function on the right-hand side from below. Therefore an intersection defines a local maximum of party j 's expected payoff. Because this local maximum is the unique critical point of the party payoff function, it must be a global maximum. Thus, if (A2) holds with equality for some value $\delta_j \in [0, \delta_j^P]$, this equality defines party j 's best response to δ_k .

These arguments also imply that party j 's best response is a corner solution $\delta_j = \delta_j^P$ if and only if

$$\frac{\phi\left(\frac{\delta_k - \delta_j}{\alpha v}\right)}{\Phi\left(\frac{\delta_k - \delta_j}{\alpha v}\right)} < \frac{\alpha v}{\delta_k + \delta_j} \text{ for all } \delta_j \in [0, \delta_j^P] \Leftrightarrow \frac{\phi\left(\frac{\delta_k - \delta_j^P}{\alpha v}\right)}{\Phi\left(\frac{\delta_k - \delta_j^P}{\alpha v}\right)} \leq \frac{\alpha v}{\delta_k + \delta_j^P}.$$

Note, however that party j 's best response to any value of δ_k is nonzero. Consider the sign of the derivative of party j 's payoff at $\delta_j = 0$. For the standard normal distribution, the following inequality holds:¹⁹

$$(A3) \quad x \geq 0 \Rightarrow \frac{\phi(x)}{\Phi(x)} < \frac{1}{x}.$$

¹⁹ To see this, let $R(x) = \frac{\phi(x)}{\Phi(x)}$. Obviously $R(0) > 0$. Furthermore, $R'(x) = \frac{\phi(x)^2 + x\phi(x)\Phi(x)}{\phi(x)^2} = 1 + xR(x) > 1$. Thus, $R(x) > x$ holds at $x = 0$, and for all $x > 0$, $R'(x) > 1$. Thus, $x > 0 \Rightarrow R(x) > x$. Inverting each side gives the inequality.

Substituting $\delta_j = 0$ into equation (A2) and applying (A3) gives

$$\frac{\phi\left(\frac{\delta_k}{\alpha v}\right)}{\Phi\left(\frac{\delta_k}{\alpha v}\right)} < \frac{\alpha v}{\delta_k} \Rightarrow \left. \frac{\partial Eu_j^P}{\partial \delta_j} \right|_{\delta_j=0} > 0.$$

Therefore, for values of δ_j near zero, the party's expected payoff is increasing in δ_j (for any δ_k); thus perfect moderation, $\delta_j = 0$ is never a best response.

Consider an interior equilibrium, $0 < \delta_L < \delta_L^P$ and $0 < \delta_R < \delta_R^P$. In an interior equilibrium, party ideologies (δ_L, δ_R) are defined by the following system of equations:

$$\frac{\phi\left(\frac{\delta_L - \delta_R}{\alpha v}\right)}{\Phi\left(\frac{\delta_L - \delta_R}{\alpha v}\right)} = \frac{\alpha v}{\delta_L + \delta_R} \quad \text{and} \quad \frac{\phi\left(\frac{\delta_R - \delta_L}{\alpha v}\right)}{\Phi\left(\frac{\delta_R - \delta_L}{\alpha v}\right)} = \frac{\alpha v}{\delta_R + \delta_L}.$$

These equations immediately imply the following:

$$\frac{\phi\left(\frac{\delta_L - \delta_R}{\alpha v}\right)}{\Phi\left(\frac{\delta_L - \delta_R}{\alpha v}\right)} = \frac{\phi\left(\frac{\delta_R - \delta_L}{\alpha v}\right)}{\Phi\left(\frac{\delta_R - \delta_L}{\alpha v}\right)}$$

$$\Leftrightarrow \Phi\left(\frac{\delta_R - \delta_L}{\alpha v}\right) = \Phi\left(-\frac{\delta_R - \delta_L}{\alpha v}\right) \Leftrightarrow \delta_L = \delta_R.$$

Thus, in any interior equilibrium, policy extremism is symmetric: $\delta_L = \delta_R = \delta^*$. Using these observations, we derive the unique interior equilibrium of the game. Suppose that $\delta_k = \delta^*$. The critical point in equation (A2) is therefore defined by

$$\frac{\phi\left(\frac{\delta^* - \delta_j}{\alpha v}\right)}{\Phi\left(\frac{\delta^* - \delta_j}{\alpha v}\right)} = \frac{\alpha v}{\delta^* + \delta_j}.$$

In equilibrium, this critical point must be $\delta_j = \delta^*$. Therefore δ^* must satisfy the following:

$$\frac{\phi(0)}{\Phi(0)} = \frac{\alpha v}{2\delta^*} \Leftrightarrow \frac{1}{\frac{\sqrt{2\pi}}{1}} = \frac{\alpha v}{2\delta^*} \Leftrightarrow \delta^* = \frac{v\sqrt{2\pi}}{4} \alpha.$$

Therefore, the unique interior equilibrium is $\delta_L = \delta_R = \delta^* \equiv \frac{v\sqrt{2\pi}}{4} \alpha$.

To establish uniqueness of the equilibrium, it is enough to exclude equilibria involving corner solutions. Note that equilibria in which either party perfectly moderates have already been excluded, as $\delta_j = 0$ is never a best response. What remains is to exclude equilibria in which at least one party nominates a candidate with its own ideology. Therefore consider the case $\delta_j < \delta_j^P$ but $\delta_k = \delta_k^P$. In order for $\delta_k = \delta_k^P$ to be party k 's best response, the following condition must hold:

$$\frac{\phi\left(\frac{\delta_j - \delta_k^P}{\alpha v}\right)}{\Phi\left(\frac{\delta_j - \delta_k^P}{\alpha v}\right)} \leq \frac{\alpha v}{\delta_j + \delta_k^P}.$$

Meanwhile, if j 's best response to δ_k^P is internal, then

$$(A4) \quad \frac{\phi\left(\frac{\delta_k^P - \delta_j}{\alpha v}\right)}{\Phi\left(\frac{\delta_k^P - \delta_j}{\alpha v}\right)} = \frac{\alpha v}{\delta_j + \delta_k^P}.$$

Combining these inequalities gives

$$\frac{\phi\left(\frac{\delta_j - \delta_k^P}{\alpha v}\right)}{\Phi\left(\frac{\delta_j - \delta_k^P}{\alpha v}\right)} \leq \frac{\phi\left(\frac{\delta_k^P - \delta_j}{\alpha v}\right)}{\Phi\left(\frac{\delta_k^P - \delta_j}{\alpha v}\right)} \Rightarrow \delta_j - \delta_k^P \geq \delta_j - \delta_k^P \Rightarrow \delta_j \geq \delta_k^P,$$

where the first implication follows from log-concavity of $\Phi(\cdot)$. Because $\delta_j \geq \delta_k^P$, it must be that $\delta_j^P \geq \delta_k^P$. Next, note that because $\delta_k^P - \delta_j \leq 0$, log-concavity implies

$$\frac{\phi\left(\frac{\delta_k^P - \delta_j}{\alpha v}\right)}{\Phi\left(\frac{\delta_k^P - \delta_j}{\alpha v}\right)} \geq \frac{\phi(0)}{\Phi(0)} = \frac{2}{\sqrt{2\pi}}.$$

Next consider (a1) noting that $\min\{\delta_j^P, \delta_k^P\} = \delta_k^P$:

$$\delta_k^P > \frac{v\sqrt{2\pi}}{4} \Rightarrow \frac{2}{\sqrt{2\pi}} > \frac{v}{2\delta_k^P}.$$

Combining these inequalities,

$$(A5) \quad \frac{\phi\left(\frac{\delta_k^P - \delta_j}{\alpha v}\right)}{\Phi\left(\frac{\delta_k^P - \delta_j}{\alpha v}\right)} \geq \frac{\phi(0)}{\Phi(0)} = \frac{2}{\sqrt{2\pi}} > \frac{v}{2\delta_k^P} \geq \frac{v}{\delta_k^P + \delta_j},$$

where the last inequality follows from $\delta_j \geq \delta_k^P$. Thus the first order condition for party j to have an interior best response, equation (A4) is violated. Therefore equilibria where one party chooses its ideal ideology is ruled out. Finally, to rule out equilibria in which both parties select their ideal ideologies. Observe that such an equilibrium would imply the following conditions:

$$\frac{\phi\left(\frac{\delta_j^P - \delta_k^P}{\alpha v}\right)}{\Phi\left(\frac{\delta_j^P - \delta_k^P}{\alpha v}\right)} \leq \frac{v}{\delta_k^P + \delta_j^P} \quad \text{and} \quad \frac{\phi\left(\frac{\delta_k^P - \delta_j^P}{\alpha v}\right)}{\Phi\left(\frac{\delta_k^P - \delta_j^P}{\alpha v}\right)} \leq \frac{v}{\delta_k^P + \delta_j^P}.$$

Without loss of generality, let $\delta_k^P \leq \delta_j^P$. As in (A5),

$$\frac{\phi\left(\frac{\delta_k^P - \delta_j^P}{\alpha v}\right)}{\Phi\left(\frac{\delta_k^P - \delta_j^P}{\alpha v}\right)} \geq \frac{\phi(0)}{\Phi(0)} > \frac{v}{2\delta_k^P} \geq \frac{v}{\delta_k^P + \delta_j^P}.$$

This is a contradiction. ■

PROOF OF PROPOSITION 1:

Given $\delta^* = \frac{v\sqrt{2\pi}}{4}\alpha$, it is straightforward to show that $\frac{\partial \delta^*}{\partial \alpha} > 0$. That is, both candidates become more extreme as either campaign becomes more informative.

A party nominates a candidate that shares ideology with the median voter when $\delta^* = 0$. Given that $v > 0$, this is the case if and only if $\alpha = 0$. Given that $\alpha \equiv \sqrt{\frac{1}{1 + \sigma_L^2} + \frac{1}{1 + \sigma_R^2}}$, it follows that $\alpha \rightarrow 0$ only as both $\sigma_L \rightarrow \infty$ and $\sigma_T \rightarrow \infty$. That is, candidate ideology converges to the median voter only when both campaigns are completely uninformative. ■

PROOF OF PROPOSITION 2:

Given quality-signal realizations s_L and s_R , the expected quality of the election winner is given by

$$q_w|s_L, s_R = \max\left\{\frac{\mu\sigma_L^2 + s_L}{\sigma_L^2 + 1}, \frac{\mu\sigma_R^2 + s_R}{\sigma_R^2 + 1}\right\}.$$

We have already shown that before the signal is realized, the posterior mean of quality $\frac{\mu\sigma_i^2 + s_i}{\sigma_i^2 + 1}$ is distributed according to $N\left(\mu, \frac{1}{1 + \sigma_i^2}\right)$. Therefore, the expected quality of the election winner is given by

$$E[q_w] = E[\max\{Q_L, Q_R\}],$$

where $Q_j \sim N\left(\mu, \frac{1}{1 + \sigma_j^2}\right)$. Using a standard formula, this expectation evaluates to

$$E[q_w] = \mu + \frac{\sqrt{\frac{1}{1 + \sigma_L^2} + \frac{1}{1 + \sigma_R^2}}}{\sqrt{2\pi}} = \mu + \frac{\alpha}{\sqrt{2\pi}}.$$

To see this, suppose $Z_i \sim N(m, s_i^2)$ and $Z \sim N(0, 1)$. Then $E[\max\{Z_1, Z_2\}] = E[Z_1] + E[\max\{0, Z_1 - Z_2\}]$. $Z_1 - Z_2 \sim N(0, s_1^2 + s_2^2) \Rightarrow Z_1 - Z_2 = \sqrt{s_1^2 + s_2^2} Z$, which in turn implies

$$\begin{aligned} E[\max\{0, Z_1 - Z_2\}] &= E[\max\{0, \sqrt{s_1^2 + s_2^2} Z\}] \\ &= \sqrt{s_1^2 + s_2^2} \int_0^\infty x\phi(x) dx = -\sqrt{s_1^2 + s_2^2} \int_0^\infty d\phi(x) \\ &= \sqrt{s_1^2 + s_2^2} \phi(0) = \sqrt{s_1^2 + s_2^2}/\sqrt{2\pi}. \end{aligned}$$

Hence $E[\max\{Z_1, Z_2\}] = \mu + \sqrt{s_1^2 + s_2^2}/\sqrt{2\pi}$.

The expected quality of the election winner is strictly increasing in overall campaign informativeness, α , and therefore also increasing in the informativeness of the individual campaigns.

Consider expected aggregate equilibrium welfare as a function of α :

$$EW(\alpha) = v \left(\mu + \frac{\alpha}{\sqrt{2\pi}} \right) - \frac{1}{2} (L(\delta^*(\alpha)) + L(-\delta^*(\alpha))).$$

Differentiating this expression gives the derivative of social welfare with respect to α :

$$\begin{aligned} \frac{\partial EW(\alpha)}{\partial \alpha} &= \frac{v}{\sqrt{2\pi}} - \frac{1}{2} (2G(\delta^*(\alpha)) - 1 - (2G(-\delta^*(\alpha)) - 1)) \frac{d\delta^*}{d\alpha} \\ &= \frac{v}{\sqrt{2\pi}} - (G(\delta^*(\alpha)) - G(-\delta^*(\alpha))) \frac{v\sqrt{2\pi}}{4}. \end{aligned}$$

From this expression for the derivative we conclude that voter welfare is decreasing in informativeness when

$$\frac{\partial EW(\alpha)}{\partial \alpha} > 0 \Leftrightarrow G(\delta^*(\alpha)) - G(-\delta^*(\alpha)) > \frac{2}{\pi}.$$

Momentarily ignoring the restriction that $\alpha \leq \sqrt{2}$, it is easy to see that aggregate voter welfare is maximized for the value $\tilde{\alpha}$ that solves

$$G(\delta^*(\tilde{\alpha})) - G(-\delta^*(\tilde{\alpha})) = \frac{2}{\pi}.$$

When both campaigns are fully informative about candidate quality, then $\alpha = \sqrt{2}$, and no higher α is possible. Therefore, if $\tilde{\alpha} \geq \sqrt{2}$, the welfare maximizing α is a corner solution at $\alpha = \sqrt{2}$. When $\tilde{\alpha} < \sqrt{2}$, then voters are best off when campaigns are less than fully informative. This is the case when

$$\left. \frac{\partial EW(\alpha)}{\partial \alpha} \right|_{\alpha=\sqrt{2}} < 0 \Leftrightarrow G\left(v \frac{\sqrt{\pi}}{2}\right) - G\left(-v \frac{\sqrt{\pi}}{2}\right) > \frac{2}{\pi}.$$

That is, if a sufficient portion of the voter population is more moderate than the candidates who are nominated when campaigns are fully informative, then voter welfare is maximized by less-than-fully informative campaigns. ■

PROOF OF PROPOSITION 3:

From the previous proof, we know that the optimal level of campaign informativeness is given by the $\tilde{\alpha}$ that solves

$$G(\delta^*(\tilde{\alpha})) - G(-\delta^*(\tilde{\alpha})) = \frac{2}{\pi}.$$

Plugging in for δ^* gives

$$G\left(\frac{v\sqrt{2\pi}}{4} \tilde{\alpha}\right) - G\left(-\frac{v\sqrt{2\pi}}{4} \tilde{\alpha}\right) = \frac{2}{\pi}.$$

We can write $\tilde{\alpha}$ as a function of v . The function incorporates constant C , which solves

$$G(C) - G(-C) = \frac{2}{\pi}.$$

Doing so gives

$$\tilde{\alpha}(v) = \frac{4C}{v\sqrt{2\pi}}.$$

As v increases, the optimal value $\tilde{\alpha}$ decreases. ■

PROOF OF PROPOSITION 4:

For voters, we assume power utility over policy outcomes, where

$$u_i = vq_w - (|\rho_w - \rho_i|)^\beta.$$

The parameter $\beta \geq 1$ represents how concave voter preferences are with respect to policy. The body of the paper considers $\beta = 1$; here we allow $\beta > 1$. To win election, a candidate must be preferred by the median voter, who has $\rho_M = 0$. Therefore, candidate L wins election if

$$vE(q_L|s_L) - \delta_L^\beta > vE(q_R|s_R) - \delta_R^\beta \Leftrightarrow E(q_L|s_L) - E(q_R|s_R) > \frac{\delta_L^\beta - \delta_R^\beta}{v}.$$

Given the distribution of q_j and s_j , we can rewrite the condition

$$(A6) \quad \frac{s_L + \mu\sigma_L^2}{1 + \sigma_L^2} - \frac{s_R + \mu\sigma_R^2}{1 + \sigma_R^2} > \frac{\delta_L^\beta - \delta_R^\beta}{v},$$

where the left-hand side is distributed according to $N(0, \alpha^2)$, where $\alpha^2 = \frac{1}{1 + \sigma_L^2} + \frac{1}{1 + \sigma_R^2}$ is our measure of campaign informativeness. The only difference between equations (A6) and (A1) is that the right-hand side now has general β rather than $\beta = 1$. Candidate L wins the election with probability $1 - \Phi\left(\frac{\delta_L^\beta - \delta_R^\beta}{v}\right)$, and candidate R wins with probability $\Phi\left(\frac{\delta_L^\beta - \delta_R^\beta}{v}\right)$. Solving for the equilibrium value of δ_L and δ_R using the same procedure as in Lemma 1 can show that in the unique equilibrium $\delta_L = \delta_R = \hat{\delta}$, where

$$\hat{\delta} = \left(\frac{v\sqrt{2\pi}}{4\beta} \alpha\right)^{\frac{1}{\beta}}.$$

First, notice that the ideology of both candidates becomes more extreme as α increases (either campaign becomes more informative) (bullet point 1).

Second, we determine when an increase in campaign informativeness can decrease voter welfare. Imagine that parties nominate candidates with extremism $\delta \geq 0$, so that candidate ideologies are $(-\delta, \delta)$. As each candidate is equally likely to win, the loss to the voter at ideology ρ is given by

$$l(\rho, \delta) \equiv \frac{1}{2}|\rho + \delta|^\beta + \frac{1}{2}|\rho - \delta|^\beta.$$

Consider losses to voters with positive ideology $\rho \geq 0$. In this case

$$l(\rho, \delta) = \begin{cases} \frac{1}{2}(\rho + \delta)^\beta + \frac{1}{2}(\delta - \rho)^\beta & \text{if } \rho \in [0, \delta] \\ \frac{1}{2}(\rho + \delta)^\beta + \frac{1}{2}(\rho - \delta)^\beta & \text{if } \rho \in [\delta, \infty] \end{cases}.$$

Next, consider the impact on losses resulting from a marginal increase in extremism:

$$(A7) \quad \frac{\partial l}{\partial \delta} = \begin{cases} \frac{\beta}{2}((\rho + \delta)^{\beta-1} + (\delta - \rho)^{\beta-1}) & \text{if } \rho \in [0, \delta] \\ \frac{\beta}{2}((\rho + \delta)^{\beta-1} - (\rho - \delta)^{\beta-1}) & \text{if } \rho \in [\delta, \infty] \end{cases}.$$

Observe that if $\beta > 2$, then $\lim_{\rho \rightarrow \infty} \frac{\partial l}{\partial \delta} = \infty$ and by analogy, $\lim_{\rho \rightarrow -\infty} \frac{\partial l}{\partial \delta} = \infty$ in the same case. (To see this, write the function in question as

$$\frac{1 - \left(\frac{\rho - \delta}{\rho + \delta}\right)^{\beta-1}}{\frac{1}{(\rho + \delta)^{\beta-1}}} \frac{\beta}{2}$$

and apply L'hospital's rule.) Next, consider the monotonicity of (A7) with respect to ρ :

$$\frac{\partial^2 l}{\partial \delta \partial \rho} = \begin{cases} \frac{\beta(\beta-1)}{2} ((\rho + \delta)^{\beta-2} - (\delta - \rho)^{\beta-2}) & \text{if } \rho \in [0, \delta] \\ \frac{\beta(\beta-1)}{2} ((\rho + \delta)^{\beta-2} - (\rho - \delta)^{\beta-2}) & \text{if } \rho \in [\delta, \infty] \end{cases}.$$

Observe that when $\beta > 2$, $x^{\beta-2}$ is an increasing function, and therefore,

$$(\rho + \delta)^{\beta-2} - (\delta - \rho)^{\beta-2} \geq 0 \Leftrightarrow \rho + \delta - (\delta - \rho) \geq 0 \Leftrightarrow 2\rho \geq 0$$

$$(\rho + \delta)^{\beta-2} - (\rho - \delta)^{\beta-2} \geq 0 \Leftrightarrow \rho + \delta - (\rho - \delta) \geq 0 \Leftrightarrow 2\delta > 0.$$

Hence for $\beta > 2$, $\partial l / \partial \delta$ is an increasing function of ρ for ρ positive. An analogous argument shows that for $\beta > 2$, $\partial l / \partial \delta$ is a decreasing function of ρ . Therefore, for $\beta > 2$ as $|\rho|$ increases (in either positive or negative direction) $\partial l / \partial \delta$ increases without bound.

Observe that when $\beta < 2$, $x^{\beta-2}$ is a decreasing function, and therefore,

$$(\rho + \delta)^{\beta-2} - (\delta - \rho)^{\beta-2} \leq 0 \Leftrightarrow \rho + \delta - (\delta - \rho) \geq 0 \Leftrightarrow 2\rho \geq 0$$

$$(\rho + \delta)^{\beta-2} - (\rho - \delta)^{\beta-2} \leq 0 \Leftrightarrow \rho + \delta - (\rho - \delta) \geq 0 \Leftrightarrow 2\delta > 0.$$

Hence for $\beta < 2$, $\partial l / \partial \delta$ is a decreasing function of ρ for ρ positive. An analogous argument shows that for $\beta < 2$, $\partial l / \partial \delta$ is an increasing function of ρ . Therefore, for $\beta < 2$ as $|\rho|$ increases (in either positive or negative direction) $\partial l / \partial \delta$ decreases. Thus, for $\beta < 2$, the median voter, $\rho = 0$ bears the highest cost of a marginal increase in policy extremism.

Next, consider expected voter welfare:

$$EW = v\mu + \frac{v}{\sqrt{2\pi}} \alpha - \int_{-\infty}^{\infty} g(\rho) l(\rho, \hat{\delta}) d\rho.$$

Differentiating this expression with respect to campaign informativeness gives

$$\frac{\partial EW}{\partial \alpha} = \frac{v}{\sqrt{2\pi}} - \frac{\partial \hat{\delta}}{\partial \alpha} \int_{-\infty}^{\infty} g(\rho) \frac{\partial l(\rho, \hat{\delta})}{\partial \delta} d\rho.$$

Consider the case $\beta < 2$. In this case, $\partial l(\rho, \hat{\delta})/\partial \hat{\delta}$ is larger for the median voter than for any other voter in the electorate, and is continuous and decreasing as ρ moves away from the median in either direction. In this case, if the median voter is strictly damaged by an increase in campaign informativeness, then an electorate sufficiently concentrated around the median voter will also be damaged by an increase in campaign informativeness. Thus, to determine when a sufficiently moderate electorate is damaged by an increase in informativeness, it is enough to determine when the median voter is damaged by an increase in informativeness. For the median voter

$$\begin{aligned} EW &= v\mu + \frac{v}{\sqrt{2\pi}} \alpha - \hat{\delta}^\beta \\ &= v\mu + \frac{v}{\sqrt{2\pi}} \alpha - \frac{v\sqrt{2\pi}}{4\beta} \alpha. \\ \frac{\partial EW}{\partial \alpha} &= \frac{v}{\sqrt{2\pi}} - \frac{v\sqrt{2\pi}}{4\beta}. \end{aligned}$$

From here it follows that for $\beta < \frac{\pi}{2}$, a distribution of voter preferences sufficiently concentrated around the median will be hurt by an increase in campaign informativeness. In particular, for $\beta < \pi/2$ an electorate with ideology normally distributed around the median voter with a sufficiently small variance will be hurt by an increase in campaign informativeness (bullet point 2). This calculation also shows that for $\pi/2 < \beta < 2$, no distribution (normal or otherwise) of voter preferences exists for which an increase in informativeness hurts welfare (bullet point 3).

To analyze $\beta > 2$, note that

$$\frac{\partial \hat{\delta}}{\partial \alpha} = \left(\frac{v\sqrt{2\pi}}{4\beta} \right)^{\frac{1}{\beta}} \alpha^{\frac{1}{\beta}-1}.$$

This is a decreasing, positive function of α . It is smallest when α takes its largest feasible value $\sqrt{2}$. Therefore is $\partial EW/\partial \alpha < 0$ for $\alpha = \sqrt{2}$, then for some range of campaign informativeness, increases in informativeness hurt welfare. This is the case when

$$\int_{-\infty}^{\infty} g(\rho) \frac{\partial l(\rho, \hat{\delta})}{\partial \hat{\delta}} d\rho > k \equiv \frac{\frac{v}{\sqrt{2\pi}}}{\left(\frac{v\sqrt{2\pi}}{4\beta} \right)^{\frac{1}{\beta}} \sqrt{2}^{\frac{1}{\beta}-1}},$$

that is, aggregate damage from an increase in extremism must exceed a constant k that is independent of the distribution of voter preferences. Because $\partial l(\rho, \hat{\delta})/\partial \hat{\delta}$ is increasing and unbounded in $|\rho|$, for any $\epsilon > 0$, it is possible to find a constant R

such that $|\rho| > R \Rightarrow \partial l(\rho, \hat{\delta})/\partial \hat{\delta} > k(1 + \epsilon)$. Consider a distribution of voter preferences with large mass in the tails, outside of $[-R, R]$:

$$\int_{-\infty}^{-R} g(\rho) d\rho + \int_R^{\infty} g(\rho) d\rho > \frac{1}{1 + \epsilon}$$

$$\int_{-\infty}^{\infty} g(\rho) \frac{\partial l(\rho, \hat{\delta})}{\partial \hat{\delta}} d\rho > \int_{-\infty}^{-R} g(\rho) \frac{\partial l(\rho, \hat{\delta})}{\partial \hat{\delta}} d\rho + \int_R^{\infty} g(\rho) \frac{\partial l(\rho, \hat{\delta})}{\partial \hat{\delta}} d\rho$$

$$> k(1 + \epsilon) \left\{ \int_{-\infty}^{-R} g(\rho) d\rho + \int_R^{\infty} g(\rho) d\rho \right\} > k.$$

Thus, any distribution with sufficient mass in the tails generates the desired result. In particular, for a normal distribution with variance s and mean zero, the mass outside interval $[-R, R]$ is equal to

$$2\Phi\left(\frac{-R}{s}\right) \rightarrow 1 \quad \text{for } s \rightarrow \infty.$$

Thus, for a normal distribution with sufficiently large variance, an increase in campaign informativeness can hurt voter welfare for $\beta > 2$ (bullet point 4). ■

A. Party Preference Nonlinearity

Although Proposition 4 focuses only on the nonlinearity of voter preferences, the body of the paper mentions nonlinearity of party preferences as well. Here, we verify claims in the body of the paper that assuming quadratic party preferences does not change our qualitative results. We anticipate that the results will continue to hold for other levels of party preference concavity. However, assuming general power utility on behalf of the parties as we do for voters above does not allow for a tractable analysis. Under quadratic party preferences, and linear voter preferences there exists parameter cases under which increased campaign informativeness decreases voter welfare. At this point, we also assume the distribution of voter preferences G is $N(0, r^2)$.

When parties have concave preferences over policy outcomes, the analysis from the body of the paper is unchanged up until we get to the party expected payoff functions given δ_L and δ_R . For any δ_L and δ_R between 0 and δ^P ,

$$Eu_L^P(\delta_L, \delta_R) = -\Phi\left(\frac{\delta_L - \delta_R}{v\alpha}\right)(\delta^P + \delta_R)^2 + \left(1 - \Phi\left(\frac{\delta_L - \delta_R}{v\alpha}\right)\right)(\delta^P - \delta_L)^2$$

$$Eu_R^P(\delta_L, \delta_R) = \Phi\left(\frac{\delta_L - \delta_R}{v\alpha}\right)(\delta^P - \delta_R)^2 + \left(1 - \Phi\left(\frac{\delta_L - \delta_R}{v\alpha}\right)\right)(\delta^P + \delta_L)^2.$$

The first order conditions of these functions with respect to the party's own candidate ideology are

$$\begin{aligned} & \phi \left(\frac{\delta_L - \delta_R}{v\alpha} \right) \frac{1}{v\alpha} \left((\delta^P - \delta_L)^2 - (\delta^P + \delta_R)^2 \right) \\ & + \left(1 - \Phi \left(\frac{\delta_L - \delta_R}{v\alpha} \right) \right) 2(\delta^P - \delta_L) = 0 \\ & \phi \left(\frac{\delta_L - \delta_R}{v\alpha} \right) \frac{1}{v\alpha} \left((\delta^P - \delta_R)^2 - (\delta^P + \delta_L)^2 \right) \\ & + \left(1 - \Phi \left(\frac{\delta_L - \delta_R}{v\alpha} \right) \right) 2(\delta^P - \delta_R) = 0, \end{aligned}$$

where the first equation represents $\frac{\partial Eu_L^P}{\partial \delta_L}$ and the second $\frac{\partial Eu_R^P}{\partial \delta_R}$. Solving these equations for δ_L and δ_R give the equilibrium solution

$$\delta^* = \delta_L^* = \delta_R^* = \frac{\alpha v \delta^P \sqrt{2\pi}}{4\delta^P + \alpha v \sqrt{2\pi}}.$$

The ideology of both candidates is strictly increasing in α . That is, both candidates become more extreme as either campaign becomes more informative.

Voter welfare is decreasing in campaign informativeness if

$$\begin{aligned} \frac{\partial EW}{\partial \alpha} &= \frac{v}{\sqrt{2\pi}} - \int_{-\infty}^{\delta^*} g(\rho) d\rho - \int_{\delta^*}^{\infty} g(\rho) d\rho \frac{\partial \delta^*}{\partial \alpha} < 0 \\ &\Leftrightarrow \frac{v}{\sqrt{2\pi}} < (2G(\delta^*) - 1) \frac{\partial \delta^*}{\partial \alpha} \\ &\Leftrightarrow \frac{v}{\sqrt{2\pi}} < (2G(\delta^*) - 1) \frac{4\delta^{P^2} v \sqrt{2\pi}}{(4\delta^P + \alpha v \sqrt{2\pi})^2} \\ &\Leftrightarrow \frac{(4\delta^P + \alpha v \sqrt{2\pi})^2}{8\delta^{P^2} \pi} < 2G(\delta^*) - 1. \end{aligned}$$

In the limit, as voters become concentrated (i.e., $r \rightarrow 1$), $G(\delta^*) \rightarrow 1$, and this condition becomes

$$(A8) \quad \frac{(4\delta^P + \alpha v \sqrt{2\pi})^2}{8\pi \delta^{P^2} \sqrt{2\pi}} < 1,$$

which holds for low enough v , since $(4\delta^P)^2 < 8\pi\delta^{P2}\sqrt{2\pi} \Leftrightarrow 2 < \pi\sqrt{2\pi}$. Similarly, for any $v > 0$ such that inequality (A8) holds, there exists a range of r small enough such that $\frac{\partial EW}{\partial \alpha} < 0$.

From this, we conclude that with quadratic party preferences, there exists a range of values for v and r such that voter welfare is decreasing in campaign informativeness.

B. Ex Ante Asymmetry

This section shows that the qualitative results from Sections IV and V continue to hold when the party candidates differ in their ex ante expected quality. The following analysis assumes that voter ideology is distributed around the median voter according to $N(0, r^2)$. The variance r represents how concentrated the population is around the median, with large r denoting a wide range of popular opinion, and $r \rightarrow 0$ representing a special case where the entire voter population shares the same ideology.

Suppose that the prior belief about the quality of the party L candidate is $q_L \sim N(\mu_L, 1)$, while the prior belief about quality for party R candidate is $q_R \sim N(\mu_R, 1)$. The analysis is unchanged, up to the calculation of the distribution of the terms on the left-hand side of equation (A1). In the text,

$$\frac{s_L + \mu\sigma_L^2}{1 + \sigma_L^2} - \frac{s_R + \mu\sigma_R^2}{1 + \sigma_R^2} \sim N(0, \alpha^2).$$

When the prior means are different, the distribution of this term is different:

$$\frac{s_L + \mu_L\sigma_L^2}{1 + \sigma_L^2} - \frac{s_R + \mu_R\sigma_R^2}{1 + \sigma_R^2} \sim N(m, \alpha^2),$$

where $m = \mu_L - \mu_R$. Following the analysis in the text, we find that the expected payoff to the parties given their choices of δ are

$$\begin{aligned} Eu_L^P(\delta_L, \delta_R) &= -\delta_L^P + \left(1 - \Phi\left(\frac{\delta_L - \delta_R - m}{v\alpha}\right)\right) (\delta_L + \delta_R) - \delta_R \\ &= -\delta_L^P + \Phi\left(\frac{\delta_R - \delta_L + m}{v\alpha}\right) (\delta_L + \delta_R) - \delta_R \\ Eu_R^P(\delta_L, \delta_R) &= \delta_R^P + \Phi\left(\frac{\delta_L - \delta_R - m}{v\alpha}\right) \delta_R - \left(1 - \Phi\left(\frac{\delta_L - \delta_R}{v\alpha}\right)\right) \delta_L \\ &= \delta_R^P + \Phi\left(\frac{\delta_L - \delta_R - m}{v\alpha}\right) (\delta_L + \delta_R) - \delta_L. \end{aligned}$$

Thus the first order conditions characterizing best-responses are

$$\Phi\left(\frac{\delta_R - \delta_L + m}{\alpha v}\right) - (\delta_R + \delta_L)\phi\left(\frac{\delta_R - \delta_L + m}{\alpha v}\right)\frac{1}{\alpha v} = 0$$

$$\Phi\left(\frac{\delta_L - \delta_R - m}{\alpha v}\right) - (\delta_R + \delta_L)\phi\left(\frac{\delta_L - \delta_R - m}{\alpha v}\right)\frac{1}{\alpha v} = 0.$$

Because the standard normal density is symmetric around zero,

$$(\delta_R + \delta_L)\phi\left(\frac{\delta_L - \delta_R - m}{\alpha v}\right)\frac{1}{\alpha v} = (\delta_R + \delta_L)\phi\left(\frac{\delta_R - \delta_L + m}{\alpha v}\right)\frac{1}{\alpha v}.$$

Thus, a Nash equilibrium with an interior optimum for each party (rather than a corner solution) requires

$$\Phi\left(\frac{\delta_L - \delta_R - m}{\alpha v}\right) = \Phi\left(-\frac{\delta_L - \delta_R - m}{\alpha v}\right).$$

For the standard normal cdf, $\Phi(x) = \Phi(-x) \Leftrightarrow x = 0$. Thus it must be that at interior optimum,

$$\frac{\delta_L - \delta_R - m}{\alpha v} = 0 \Leftrightarrow \delta_L = \delta_R + m.$$

Observe that these equations also imply that at a Nash equilibrium with interior optimality, both parties are equally likely to win election. Combining this equation with either first order condition for party R gives the following:

$$\frac{1}{2} - \frac{m + 2\delta_R}{v\alpha\sqrt{2\pi}} = 0.$$

This equation immediately implies that

$$\delta_R = \frac{v\sqrt{2\pi}}{4}\alpha - \frac{m}{2} \quad \text{and} \quad \delta_L = \frac{v\sqrt{2\pi}}{4}\alpha + \frac{m}{2}.$$

Compared with the symmetric case, the party with the greater expected quality chooses a more extreme position, while the other party adopts a more moderate position. As long as the difference in the means, m , is less than $\frac{v\sqrt{2\pi}}{2}\alpha$ both solutions are interior and constitute an equilibrium. If m is greater than this threshold, then the disadvantaged party perfectly moderates, running a candidate with the median voter's ideology. For subsequent welfare analysis, we focus on the case of small differences in ex ante means.

Unlike the case considered in the body, because the party positions are asymmetric, the election winner is not the candidate who generates the higher realized quality. Rather, the election winner is the candidate who generates a higher expected

surplus for the median voter. Let Q_j represent the ex ante distribution of the posterior mean of quality:

$$Q_j = \frac{s_j + \mu_j \sigma_i^2}{1 + \sigma_j^2}.$$

The expected surplus offered to the median voter at the interim stage is therefore

$$U_j = vQ_j - \delta_j.$$

As discussed in text, $Q_j \sim N\left(\mu_j, \frac{1}{1 + \sigma_j^2}\right)$, and hence, $U_j \sim N\left(v\mu_j - \delta_j, \frac{v^2}{1 + \sigma_j^2}\right)$. As $r \rightarrow 0$ the expected utility of the electorate approaches the expected utility of the median voter, which is simply $E[\max\{U_L, U_R\}]$. According to a standard formula, the expected value of the maximum order statistic drawn from two independent normals, $N(\nu_j, \theta_j^2)$ is given by

$$\nu_2 + (\nu_1 - \nu_2)\Phi\left(\frac{\nu_1 - \nu_2}{\sqrt{\theta_1^2 + \theta_2^2}}\right) + \sqrt{\theta_1^2 + \theta_2^2} \phi\left(\frac{\nu_1 - \nu_2}{\sqrt{\theta_1^2 + \theta_2^2}}\right).$$

In this formula the two critical quantities are the difference in means, and the sum of the variances. In our case, these evaluate as follows:

$$\nu_1 - \nu_2 = v\mu_L - \delta_L - v\mu_R + \delta_R = m(v - 1)$$

$$\sqrt{\theta_1^2 + \theta_2^2} = \sqrt{\frac{v^2}{1 + \sigma_L^2} + \frac{v^2}{1 + \sigma_R^2}} = v\alpha.$$

Thus, this formula evaluates to

$$v\mu_R - \delta_R + m(v - 1)\Phi\left(\frac{m(v - 1)}{v\alpha}\right) + v\alpha\phi\left(\frac{m(v - 1)}{v\alpha}\right).$$

The derivative of this expression with respect to α is given by

$$\begin{aligned} & -\frac{v\sqrt{2\pi}}{4} + \frac{m^2(v - 1)^2}{v\alpha^2} \phi\left(\frac{m(v - 1)}{v\alpha}\right) \\ & + v\phi\left(\frac{m(v - 1)}{v\alpha}\right) - \frac{m^2(v - 1)^2}{v\alpha^2} \phi\left(\frac{m(v - 1)}{v\alpha}\right), \end{aligned}$$

which becomes just

$$-\frac{v\sqrt{2\pi}}{4} + v\phi\left(\frac{m(v - 1)}{v\alpha}\right).$$

Because the largest value for the normal pdf is $\frac{1}{\sqrt{2\pi}}$ and $\frac{1}{\sqrt{2\pi}} - \frac{\sqrt{2\pi}}{4} < 0$, our result that voter welfare is decreasing in campaign informativeness when voters are sufficiently concentrated around the mean continues to hold. Our main result is robust to ex ante differentiation among candidates, provided this differentiation is not too large.

PROOF OF LEMMA 2:

Given candidate extremism δ_L and δ_R , candidate L wins election if

$$E(q_L|s_L) - E(q_R|s_R) > \frac{\delta_L - \delta_R}{v} \Leftrightarrow \hat{Q} > \frac{\delta_L - \delta_R}{v},$$

analogous to the model with normal distributions. According to our definition of $H(\cdot)$, candidate L wins with probability $1 - H\left(\frac{\delta_L - \delta_R}{v}\right)$ and candidate R wins with probability $H\left(\frac{\delta_L - \delta_R}{v}\right)$. By symmetry of the posterior mean difference random variable, party j wins with probability $H\left(\frac{\delta_k - \delta_j}{v}\right)$. Hence party j 's expected utility is

$$Eu_j^P(\delta_j, \delta_k) = -H\left(\frac{\delta_k - \delta_j}{v}\right)(\delta_j^P - \delta_j) - \left(1 - H\left(\frac{\delta_k - \delta_j}{v}\right)\right)(\delta_j^P + \delta_k).$$

Consider the derivative of this function in the party's choice of ideological divergence:

$$\frac{\partial Eu_j^P}{\partial \delta_j} = H\left(\frac{\delta_k - \delta_j}{v}\right) - h\left(\frac{\delta_k - \delta_j}{v}\right) \frac{\delta_j + \delta_k}{v}$$

and hence,

$$(A9) \quad \frac{\partial Eu_j^P}{\partial \delta_j} \geq 0 \Leftrightarrow \frac{h\left(\frac{\delta_k - \delta_j}{v}\right)}{H\left(\frac{\delta_k - \delta_j}{v}\right)} \leq \frac{v}{\delta_j + \delta_k}.$$

Temporarily consider $\delta_j \in R^1$, ignoring the upper bound imposed by party ideology. Observe that by assumption (a3) (log-concavity of $H(\cdot)$), the left-hand side of (A9) is an increasing function of δ_j (the reverse hazard rate $h(\cdot)/H(\cdot)$ is decreasing in its argument, while the argument is decreasing in δ_j). Meanwhile, the right-hand side is a strictly decreasing function of δ_j , which approaches zero as $\delta_j \rightarrow \infty$. Hence, for a specific value of δ_k , (A9) holds as an equality for no more than one value of δ_j . Furthermore, whenever an intersection exists between the left and right-hand side of (A9), the left-hand side intersects the right-hand side from below; therefore, the critical points defined by the intersection is a maximum. As no other critical point exists, whenever a critical point exists it is a global maximum. If no intersection exists for all values of $\delta_j \geq 0$, then it must be that the left-hand side is

bigger than the right-hand side for all $\delta_j \geq 0$. In this case, party j 's payoff function is monotonically decreasing in δ_j . The third alternative is that the left-hand side is below the right-hand side at $\delta_j = 0$, but the intersection occurs at a value of δ_j that exceeds the party's ideal point δ_j^P . In this case the party best response is a corner solution, $\delta_j = \delta_j^P$.

The argument of the preceding paragraph implies the following observations:

- If $\frac{h(\delta_k/v)}{H(\delta_k/v)} < v/\delta_k$ party j 's best response to δ_k is strictly bigger than zero.
- An interior best response, $\delta_j < \delta_j^P$ is characterized by equality in condition (A9).
- Party j 's best response is a corner solution $\delta_j = \delta_j^P$ whenever

$$\frac{h\left(\frac{\delta_k - \delta_j}{v}\right)}{H\left(\frac{\delta_k - \delta_j}{v}\right)} < \frac{v}{\delta_k + \delta_j} \quad \text{for all } \delta_j < \delta_j^P \Leftrightarrow \frac{h\left(\frac{\delta_k - \delta_j^P}{v}\right)}{H\left(\frac{\delta_k - \delta_j^P}{v}\right)} \leq \frac{v}{\delta_k + \delta_j^P}.$$

- If $\frac{h(\delta_k/v)}{H(\delta_k/v)} \geq v/\delta_k$ party j 's best response to δ_k is $\delta_j = 0$.

Note that the third condition immediately implies that $\delta_j = \delta_k = 0$ cannot be an equilibrium, as $\delta_k = 0$ implies that $v/\delta_k = \infty$ while $h(0)/H(0) < \infty$. Therefore, the best response to $\delta_k = 0$ cannot be $\delta_j = 0$.

Next, consider a possible equilibrium (δ_L, δ_R) in which both δ_L and δ_R are interior (strictly greater than zero but strictly less than the party ideology) but not necessarily identical. If both parties' equilibrium ideologies are interior, they must be characterized by equality in condition (A9) for both parties. Hence,

$$\text{Party L: } \frac{h\left(\frac{\delta_R - \delta_L}{v}\right)}{H\left(\frac{\delta_R - \delta_L}{v}\right)} = \frac{v}{\delta_L + \delta_R} \quad \text{Party R: } \frac{h\left(\frac{\delta_L - \delta_R}{v}\right)}{H\left(\frac{\delta_L - \delta_R}{v}\right)} = \frac{v}{\delta_L + \delta_R}.$$

Combining these conditions gives the following:

$$\frac{h\left(\frac{\delta_R - \delta_L}{v}\right)}{H\left(\frac{\delta_R - \delta_L}{v}\right)} = \frac{h\left(\frac{\delta_L - \delta_R}{v}\right)}{H\left(\frac{\delta_L - \delta_R}{v}\right)},$$

and because the reverse hazard rate is strictly decreasing, we find

$$\frac{\delta_R - \delta_L}{v} = \frac{\delta_L - \delta_R}{v} \Rightarrow \delta_L = \delta_R.$$

Substituting $\delta_L = \delta_R = \bar{\delta}$ into (A9) with equality, and solving:

$$(A10) \quad \frac{h(0)}{H(0)} = \frac{v}{2\bar{\delta}} \Rightarrow \bar{\delta} = \frac{v}{4h(0)},$$

where use has been made of the property $H(0) = 1/2$, implied by symmetry of the density. Thus, the only possible equilibrium in which both parties nominate candidates with strictly interior ideologies is described by (A10). (a1') guarantees that this level of ideological divergence does not exceed the party's ideology. We have therefore shown that under (a1'), (a2), and (a3), that the only equilibrium in which both parties nominate candidates of interior ideology has $\delta_L = \delta_R$ and is characterized as described in the lemma. In addition $\delta_L = \delta_R = 0$ has been ruled out. These observations establish the first two statements in the lemma.

To establish the third statement, note that four types of asymmetric equilibrium must be ruled out. (i) One party moderates perfectly and the second party chooses an interior level of extremism, $\delta_j = 0$, $\delta_k < \delta_k^P$. (ii) One party moderates perfectly and the second party does not moderate at all, $\delta_j = 0$, $\delta_k = \delta_k^P$. (iii) One party does not moderate at all and the other party selects interior extremism, $\delta_j < \delta_j^P$, $\delta_k = \delta_k^P$. (iv) Neither party moderates at all $\delta_j = \delta_j^P$ and $\delta_k = \delta_k^P$.

Consider cases (i) and (ii), supposing $\delta_j = 0$ and $\delta_k > 0$. For j 's best response to δ_k to be $\delta_j = 0$, it must be that

$$\frac{h(\delta_k/v)}{H(\delta_k/v)} \geq v/\delta_k.$$

If k 's best response is bigger than zero, it is either an internal best response, defined by an equality in (A9), or a corner solution at $\delta_k = \delta_k^P$. Therefore, given $\delta_j = 0$, for party k 's best response it must be that $du_k/d\delta_k \geq 0$, that is,

$$\frac{h(-\delta_k/v)}{H(-\delta_k/v)} \leq v/\delta_k.$$

Together, these inequalities imply

$$\frac{h(-\delta_k/v)}{H(-\delta_k/v)} \leq \frac{h(\delta_k/v)}{H(\delta_k/v)}.$$

Because $\delta_k > 0$, this inequality contradicts the assumption that the reverse hazard rate $h(\cdot)/H(\cdot)$ is a decreasing function.

To rule out (iii) consider the case $\delta_j < \delta_j^P$ and $\delta_k = \delta_k^P$. Following the observations about best responses, in order for $\delta_k = \delta_k^P$ to be party k 's best response, it must be that

$$\frac{h\left(\frac{\delta_j - \delta_k^P}{v}\right)}{H\left(\frac{\delta_j - \delta_k^P}{v}\right)} \leq \frac{v}{\delta_j + \delta_k^P}.$$

Meanwhile, if j 's best response to δ_k^P is internal, then

$$\frac{h\left(\frac{\delta_k^P - \delta_j}{v}\right)}{H\left(\frac{\delta_k^P - \delta_j}{v}\right)} = \frac{v}{\delta_j + \delta_k^P}.$$

Combining these inequalities gives

$$\frac{h\left(\frac{\delta_j - \delta_k^P}{v}\right)}{H\left(\frac{\delta_j - \delta_k^P}{v}\right)} \leq \frac{h\left(\frac{\delta_k^P - \delta_j}{v}\right)}{H\left(\frac{\delta_k^P - \delta_j}{v}\right)} \Rightarrow \delta_j - \delta_k^P \geq \delta_j - \delta_k^P \Rightarrow \delta_j \geq \delta_k^P.$$

Where the first implication follows from log-concavity of $H(\cdot)$. Because $\delta_j \geq \delta_k^P$, it must be that $\delta_k^P \leq \delta_j^P$. Next, note that because $\delta_k^P - \delta_j \leq 0$, log-concavity implies

$$\frac{h\left(\frac{\delta_k^P - \delta_j}{v}\right)}{H\left(\frac{\delta_k^P - \delta_j}{v}\right)} \geq \frac{h(0)}{H(0)}.$$

Next consider (a1'), noting that $\min\{\delta_j^P, \delta_k^P\} = \delta_k^P$:

$$\delta_k^P > \frac{v}{4h(0)} \Rightarrow \frac{h(0)}{H(0)} > \frac{v}{2\delta_k^P},$$

where use has been made of $H(0) = 1/2$, implied by symmetry. Combining these inequalities,

$$(A11) \quad \frac{h\left(\frac{\delta_k^P - \delta_j}{v}\right)}{H\left(\frac{\delta_k^P - \delta_j}{v}\right)} \geq \frac{h(0)}{H(0)} > \frac{v}{2\delta_k^P} \geq \frac{v}{\delta_k^P + \delta_j},$$

where the last inequality follows from $\delta_j \geq \delta_k^P$. Thus the first order condition for party j to have an interior best response, equation (A4) is violated. Therefore equilibria where one party chooses its ideal ideology is ruled out. Finally, to rule out equilibria in which both parties select their ideal ideologies. Observe that such an equilibrium would imply the following conditions:

$$\frac{h\left(\frac{\delta_j^P - \delta_k^P}{v}\right)}{H\left(\frac{\delta_j^P - \delta_k^P}{v}\right)} \leq \frac{v}{\delta_k^P + \delta_j^P} \quad \text{and} \quad \frac{h\left(\frac{\delta_k^P - \delta_j^P}{v}\right)}{H\left(\frac{\delta_k^P - \delta_j^P}{v}\right)} \leq \frac{v}{\delta_k^P + \delta_j^P}.$$

Without loss of generality, let $\delta_k^P \leq \delta_j^P$. As in (A11),

$$\frac{h\left(\frac{\delta_k^P - \delta_j^P}{v}\right)}{H\left(\frac{\delta_k^P - \delta_j^P}{v}\right)} \geq \frac{h(0)}{H(0)} > \frac{v}{2\delta_k^P} \geq \frac{v}{\delta_k^P + \delta_j^P}.$$

This is a contradiction. ■

PROOF OF PROPOSITION 5:

Point 1: The unique equilibrium is symmetric. Therefore, the candidate with higher realized posterior mean quality wins election: candidate j wins if and only if $E[q_j|s_j] > E[q_k|s_k]$. Thus the realized quality of the election winner is $w \equiv \max\{E[q_L|s_L], E[q_R|s_R]\} = E[q_R|s_R] + \max\{E[q_L|s_L] - E[q_R|s_R], 0\}$. From an ex ante perspective, expected quality of the election winner is a random variable:

$$W \equiv E[q_R|s_R] + \max\{E[q_L|s_L] - E[q_R|s_R], 0\} = E[q_R|s_R] + \max\{\hat{Q}, 0\}.$$

Next, note that the mean of the expected quality of the election winner is given by

$$E[W] = E[E[q_R|s_R]] + E[\max\{\hat{Q}, 0\}] = \mu + E[\max\{\hat{Q}, 0\}],$$

where μ represents the expected quality of candidate R under the prior (use has been made of the Law of Iterated Expectations). Next, consider $\hat{Q}_\alpha \sim H_\alpha(\cdot)$ and $\hat{Q}_\beta \sim H_\beta(\cdot)$ that satisfy the assumptions of this section, where information structure α dominates β in the RO-precision order, and thus $H_\alpha(\cdot)$ is flatter in the rotation order than $H_\beta(\cdot)$. Observe that

$$E[\max\{\hat{Q}_i, 0\}] = \Pr(\hat{Q}_i \geq 0)E[\hat{Q}_i|\hat{Q}_i \geq 0] = \frac{1}{2}E[\hat{Q}_i|\hat{Q}_i \geq 0].$$

Next, consider the distribution function of random variable $\hat{Q}_i|\hat{Q}_i \geq 0$. The distribution function of this random variable is $\hat{H}_i(x) \equiv (H_i(x) - H_i(0))/(1 - H_i(0)) = 2H_i(x) - 1$, defined on $[0, \bar{q}_i]$, where (recall that) \bar{q}_i is the maximum element of the support of \hat{Q}_i . Because $H_\alpha(\cdot)$ is flatter than $H_\beta(\cdot)$ in the rotation order, and the rotation point is zero under (a2), for all $x \in [0, \bar{q}_b]$, $H_\alpha(x) < H_\beta(x)$. Thus, $\hat{H}_\alpha(x) < \hat{H}_\beta(x)$ for $x \in [0, \bar{q}_b]$ which implies that random variable $\hat{Q}_\alpha|\hat{Q}_\alpha \geq 0$ first order stochastically dominates $\hat{Q}_\beta|\hat{Q}_\beta \geq 0$ (with strict inequality everywhere in the interior of the support $(0, \bar{q}_a)$), and hence, $E[\hat{Q}_\alpha|\hat{Q}_\alpha \geq 0] > E[\hat{Q}_\beta|\hat{Q}_\beta \geq 0]$. This inequality immediately yields the desired result.

Points 2 and 3: If signal structure α is more RO-precise than β , then $H_\alpha(\cdot)$ is flatter in the rotation order than $H_\beta(\cdot)$, and because (a2) is satisfied, the rotation point must be zero. Immediately it follows that $h_\alpha(0) \leq h_\beta(0)$. Hence, equilibrium extremism under α , given by $v/(4h_\alpha(0))$ is no less than under β , given by $v/(4h_\beta(0))$. Indeed, with strong RO-informativeness, $h_\alpha(0) < h_\beta(0)$, and therefore equilibrium extremism is strictly higher with α than β . ■

REFERENCES

- Alesina, Alberto F., and Richard T. Holden.** 2008. "Ambiguity and Extremism in Elections." National Bureau of Economic Research (NBER) Working Paper 14143.
- Aragones, Enriqueta, and Thomas R. Palfrey.** 2002. "Mixed Equilibrium in a Downsian Model with a Favored Candidate." *Journal of Economic Theory* 103 (1): 131–61.
- Ashworth, Scott.** 2006. "Campaign Finance and Voter Welfare with Entrenched Incumbents." *American Political Science Review* 100 (1): 55–68.
- Ashworth, Scott, and Ethan Bueno de Mesquita.** 2009. "Elections with platform and valence competition." *Games and Economic Behavior* 67 (1): 191–216.
- Bagnoli, Mark, and Ted Bergstrom.** 2005. "Log-concave probability and its applications." *Economic Theory* 26 (2): 445–69.
- Berinsky, Adam J., and Jeffrey B. Lewis.** 2007. "An Estimate of Risk Aversion in the U.S. Electorate." *Quarterly Journal of Political Science* 2 (2): 139–54.
- Bernhardt, Dan, Odilon Câmara, and Francesco Squintani.** 2011. "Competence and Ideology." *Review of Economic Studies* 78 (2): 487–522.
- Bernhardt, Dan, John Duggan, and Francesco Squintani.** 2009. "The Case for Responsible Parties." *American Political Science Review* 103 (4): 570–87.
- Besley, Timothy, and Stephen Coate.** 1997. "An Economic Model of Representative Democracy." *Quarterly Journal of Economics* 112 (1): 85–114.
- Calvert, Randall L.** 1985. "Robustness of the multidimensional voting model: candidate motivations, uncertainty, and convergence." *American Journal of Political Science* 29 (1): 69–95.
- Câmara, Odilon.** 2008. "Economic policies of heterogeneous politicians." Unpublished.
- Câmara, Odilon, and Dan Bernhardt.** 2014. "Learning about challengers." <http://www-bcf.usc.edu/~ocamara/learningchallengers.pdf>.
- Carrillo, Juan D., and Micael Castanheira.** 2008. "Information and Strategic Political Polarization." *Economic Journal* 118 (530): 845–74.
- Chakraborty, Archishman, and Parikshit Ghosh.** 2013. "Character Endorsements and Electoral Competition." Delhi School of Economics Center for Development Economics Working Paper 234.
- Coate, Stephen.** 2004a. "Pareto-Improving Campaign Finance Policy." *American Economic Review* 94 (3): 628–55.
- Coate, Stephen.** 2004b. "Political Competition with Campaign Contributions and Informative Advertising." *Journal of the European Economic Association* 2 (5): 772–804.
- Crutzen, Benoit S. Y., Micael Castanheira, and Nicolas Sahuguet.** 2010. "Party Organization and Electoral Competition." *Journal of Law Economics & Organization* 26 (2): 212–42.
- Eguia, Jon X., and Antonio Nicolo.** 2012. "On the Efficiency of Partial Information in Elections." <https://www.gate.cnrs.fr/IMG/pdf/CollegioCA.pdf>.
- Eyster, Erik, and Thomas Kittsteiner.** 2007. "Party platforms in electoral competition with heterogeneous constituencies." *Theoretical Economics* 2 (1): 41–70.
- Ganuza, Juan-José, and José S. Penalva.** 2007. "Signal Orderings Based on Dispersion and Private Information Disclosure in Auctions." Unpublished.
- Ganuza, Juan-José, and José S. Penalva.** 2010. "Signal Orderings Based on Dispersion and the Supply of Private Information in Auctions." *Econometrica* 78 (3): 1007–30.
- Gerber, Alan.** 1998. "Estimating the Effect of Campaign Spending on Senate Election Outcomes Using Instrumental Variables." *American Political Science Review* 92 (2): 401–11.
- Groseclose, Tim.** 2001. "A Model of Candidate Location When One Candidate Has a Valence Advantage." *American Journal of Political Science* 45 (4): 862–86.
- Herrera, Helios, David K. Levine, and César Martinelli.** 2008. "Policy platforms, campaign spending and voter participation." *Journal of Public Economics* 92 (3–4): 501–13.
- Ivanov, Maxim.** 2013. "Information revelation in competitive markets." *Economic Theory* 52 (1): 337–65.
- Johnson, Justin P., and David P. Myatt.** 2006. "On the Simple Economics of Advertising, Marketing, and Product Design." *American Economic Review* 96 (3): 756–84.
- Lind, Jo Thori, and Dominic Rohner.** 2011. "Knowledge is power: A theory of information, income, and welfare spending." University of Zurich Department of Economics Working Paper 36.
- McCarty, Nolan, Keith T. Poole, and Howard Rosenthal.** 2006. *Polarized America: The dance of ideology and unequal riches*. Cambridge, MA: MIT Press.
- Meirowitz, Adam.** 2008. "Electoral Contests, Incumbency Advantages, and Campaign Finance." *Journal of Politics* 70 (3): 681–99.

- Moscarini, Giuseppe, and Marco Ottaviani.** 2001. "Price competition for an informed buyer." *Journal of Economic Theory* 101 (2): 457–93.
- Potters, Jan, Randolph Sloof, and Frans van Winden.** 1997. "Campaign expenditures, contributions and direct endorsements: The strategic use of information and money to influence voter behavior." *European Journal of Political Economy* 13 (1): 1–31.
- Prat, Andrea.** 2002a. "Campaign Advertising and Voter Welfare." *Review of Economic Studies* 69 (4): 997–1017.
- Prat, Andrea.** 2002b. "Campaign spending with office-seeking politicians, rational voters, and multiple lobbies." *Journal of Economic Theory* 103 (1): 162–89.
- Prat, Andrea.** 2008. "Rational voters and political advertising." In *Oxford Handbook of Political Economy*, edited by Donald A. Wittman and Barry R. Weingast, 50–63. Oxford: Oxford University Press.
- Sahuguet, Nicolas, and Nicola Persico.** 2006. "Campaign spending regulation in a model of redistributive politics." *Economic Theory* 28 (1): 95–124.
- Serra, Gilles.** 2010. "Polarization of What? A Model of Elections with Endogenous Valence." *Journal of Politics* 72 (2): 426–37.
- Shi, Xianwen.** 2012. "Optimal auctions with information acquisition." *Games and Economic Behavior* 74 (2): 666–86.
- Wittman, Donald.** 1983. "Candidate Motivation: A Synthesis of Alternative Theories." *American Political Science Review* 77 (1): 142–57.

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3. Nobuhiro Mizuno, Ryosuke Okazawa. 2022. Why do voters elect less qualified candidates?. *Journal of Theoretical Politics* **34**:3, 443-477. [[Crossref](#)]
4. Giovanni Andreottola. 2021. Signaling valence in primary elections. *Games and Economic Behavior* **126**, 1-32. [[Crossref](#)]
5. Leyla D. Karakas, Devashish Mitra. 2020. Inequality, redistribution and the rise of outsider candidates. *Games and Economic Behavior* **124**, 1-16. [[Crossref](#)]
6. Alexis Antoniadis, Charles W. Calomiris. 2020. Mortgage market credit conditions and U.S. Presidential elections. *European Journal of Political Economy* **64**, 101909. [[Crossref](#)]
7. Siddhartha Bandyopadhyay, Kalyan Chatterjee, Jaideep Roy. 2020. EXTREMIST PLATFORMS: POLITICAL CONSEQUENCES OF PROFIT-SEEKING MEDIA. *International Economic Review* **61**:3, 1173-1193. [[Crossref](#)]
8. Archishman Chakraborty, Parikshit Ghosh, Jaideep Roy. 2020. Expert-Captured Democracies. *American Economic Review* **110**:6, 1713-1751. [[Abstract](#)] [[View PDF article](#)] [[PDF with links](#)]
9. Nicolas Motz. 2019. Who emerges from smoke-filled rooms? Political parties and candidate selection. *Social Choice and Welfare* **52**:1, 161-196. [[Crossref](#)]
10. Livio Di Lonardo. 2017. Valence uncertainty and the nature of the candidate pool in elections. *Journal of Theoretical Politics* **29**:2, 327-350. [[Crossref](#)]
11. Ricardo Alonso, Odilon Câmara. 2016. Political disagreement and information in elections. *Games and Economic Behavior* **100**, 390-412. [[Crossref](#)]
12. Archishman Chakraborty, Parikshit Ghosh. 2016. Character Endorsements and Electoral Competition. *American Economic Journal: Microeconomics* **8**:2, 277-310. [[Abstract](#)] [[View PDF article](#)] [[PDF with links](#)]
13. Marina Dodlova, Galina Zudenkova. 2016. Incumbents' Performance and Political Polarization. *SSRN Electronic Journal* . [[Crossref](#)]
14. Mehdi Shadmehr. 2015. Extremism in revolutionary movements. *Games and Economic Behavior* **94**, 97-121. [[Crossref](#)]
15. Camilo Garcia-Jimeno, Pinar Yildirim. 2015. Matching Pennies on the Campaign Trail: An Empirical Study of Senate Elections and Media Coverage. *SSRN Electronic Journal* **103**. . [[Crossref](#)]
16. Livio Di Lonardo. 2013. Negative Valence Shocks, Candidate Entry and Asymmetric Polarization. *SSRN Electronic Journal* . [[Crossref](#)]