Information Transmission by Imperfectly Informed Parties

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Abstract

Situations abound where decision makers (like voters) rely on the information of better informed but self-interested parties. I study the question whether in such situations competing parties (or experts) can transmit their superior information to the electorate (or customers) through their equilibrium policy proposals. The answer I find is yes, but only if the parties' information is sufficiently *noisy*. In my model two office motivated parties first receive noisy but informative private signals about which of two states is true and then simultaneously propose policies. The voter's bliss point policy varies monotonically with her belief about the two states. She receives no signal, but observing the policies she updates her beliefs and votes for the party whose policy maximizes her expected utility. This model exhibits a continuum of pooling intuitive equilibria and a unique pooling equilibrium satisfying the PSE refinement (Grossman and Perry, 1986). If the signals' error probability is smaller than the prior on both states, then generically no separating intuitive equilibrium exists. However, if the prior on one state is smaller than the signals' error probability, the model exhibits fully separating intuitive equilibria and a unique separating PSE and a unique separating D1 equilibrium. The model's empirical predictions are thus that policy platforms converge when the issues at hand are well understood but that they may diverge when they are not.

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> Democracy is a form of government that substitutes election by the incompetent many for appointment by the corrupt few.
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> George Bernard Shaw

1 Introduction

There are many real world situations where decision makers who are uncertain about facts relevant for the decision choose from a menu offered by competing and better informed experts, or parties, each of whom wants its proposal to be chosen. For example, financial investment advisors compete for clients by offering portfolios tailored to their clients; newspapers compete for readership by offering possibly informative stories; architects compete by offering possibly different designs to the potential client, and political parties running for office compete for support from the electorate by campaigning with their policy platforms. I study the question whether in equilibrium the superior information of the parties can be transmitted to the decision makers. The answer I find is yes, but only if the parties' information is sufficiently noisy.

The model I study can be sketched as follows. To fix ideas, assume from here onwards that the competitors in question are two political parties and that the decision maker is the median voter. Parties are purely office motivated. There are two states of the world, the policy space is continuous and the voter's unique bliss point policy varies monotonically with her belief.[1] The timing is such that each party first observes a private signal that, conditional on the state, indicates the true state with probability greater than a half, and the other state otherwise. A signal is called strong (weak) if the probability that the other party has received the same signal exceeds (is less than) a half.[2] Second, the two parties simultaneously propose their policies, which they are committed to implement upon being elected into office. Observing these policies, the voter updates her beliefs and votes for the party whose policy maximizes her expected utility.

The following results are obtained under the assumption that the voter employs a symmetric strategy.[3] First, in any such equilibrium, conditional on its signal each party is elected with equal probability independently of the signal. Second, for any precision of the signals, there

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[1] For example, the two states may be that another country has weapons of mass destruction or that it has not. The policy space is defense expenditure.

[2] A signal is strong (weak) if the probability, conditional on the state, that the signal is correct exceeds (is less than) the common prior on that state. Consequently, at least one signal is always strong.

[3] The voter's strategy is called symmetric if the probability that she elects party 1 given that party 1 proposes policy x and party 2 proposes y is equal to the probability that she elects party 2 if 1 proposes y and 2 proposes x.

is a continuum of equilibria that are pooling and satisfy the Intuitive Criterion of Cho and Kreps (1987) and the D1 criterion Cho and Kreps (1987); Banks and Sobel (1987) appropriately extended to sender-receiver games with two senders. Amongst these intuitive pooling equilibria there is a unique equilibrium satisfying the PSE refinement based on Grossman and Perry (1986). In this equilibrium both parties pool at the voter's bliss point policy given the prior. The reason that both the Intuitive Criterion and D1 have no bite here is essentially that there are no signaling costs in a pooling equilibrium: A party could benefit from a deviation independently of the signal. On the other hand, the PSE refinement has bite because it requires the voter to assign prior preserving beliefs in this case. Consequently her belief will equal the prior both on and off-the-equilibriumpath. Thus, in a pooling equilibrium the voter's bliss point policy will be the same both on and off-the-equilibrium path.

Third, when both signals are strong there is generically no separating equilibrium that satisfies the Intuitive Criterion. Having received a strong signal, call it a, a party would be willing to deviate from a candidate separating equilibrium strategy if that deviation leads to election with probability one if the other party has received the same signal (and plays according to equilibrium) and to election with probability zero if the other party has received the other signal. The reason is that the probability that the other party has received the same signal exceeds one half because the signal is strong and because on the equilibrium path each party wins with probability of a half. By the same token, having received the other signal, call it b, a party has no incentive to deviate to a policy that yields a win with probability one if the other party has received signal a and with probability zero otherwise. That such a profitable deviation generically exists follows essentially from the continuity (and other fairly standard) properties of the utility function (Proposition 1).

Fourth, when one signal is weak, separating equilibria satisfying the Intuitive Criterion exist, and there is a unique separating PSE and a unique separating D1 equilibrium. The reason, in a nutshell, is that now a party would benefit from the same deviation that defeats the other party if and only if the other party has received the strong signal both upon the weak and the strong signal. This eliminates the additional constraint that makes the existence of separating equilibria non-generic when both signals are strong.

Since separating intuitive equilibria exist when one signal is weak but generically not when both signals are strong, and assuming that a separating equilibrium is played when one exists, the model makes the very intuitive prediction that policy convergence occurs on issues that are well understood, but that policies can diverge if the issues are little understood and political parties' expertise is limited. The somewhat subtle twist, though, is that if convergence occurs policies converge to a completely uninformative, common wisdom type of policy. To the best of my knowledge, these predictions are novel. In principle, they can be tested empirically. Extensions show, amongst other things, that these results are robust to the introduction of cheap talk messages. However, if parties move sequentially instead of simultaneously, a separating PSE exists.

Political parties in the present model are imperfectly informed senders, whose *messages* to the electorate take the form of policy proposals.[4] Therefore, the paper is related to the cheap talk literature initiated by Crawford and Sobel (1982); see also Gilligan and Krehbiel (1989), Austen-Smith (1990) and Krishna and Morgan (2001b,a). Indeed, there is no cost inherent in messages, or policy proposals, to the parties other than the indirect cost that policy proposals affect the voter's decision. However, messages, or policy proposals, are not costless to the voter since they constrain her choice set. A second important difference to the cheap talk literature is the structure of preferences. In my model each sender wants the receiver to think that, in some sense, the state is 'closer' to the message he sends than to the message sent by the other sender whereas in the typical cheap talk game the sender wants the receiver to believe that the state is equal to the true state plus some bias. Another important difference from the typical cheap talk model is that here senders are not assumed to be perfectly informed about the state of the world. Krishna and Morgan (2001b, p.769) acknowledge that "[i]n practice, the information of experts is neither perfect nor identical".[5] The present framework provides a tractable departure from the assumption of perfect and identical information. Notwithstanding these differences, the arbitrage condition underlying the equilibrium construction in Crawford and Sobel (1982) and Krishna and Morgan (2001b) relies on the same concavity property of the utility function as the separating equilibrium here. Consequently, the informative equilibrium in the present paper, if it exists, rests on a very similar ground. In a subtle but important difference, however, here the arbitrage condition applies to the *receiver* (voter) rather than to the *sender(s)* (party or parties) as in Crawford and Sobel (1982) and Krishna and Morgan

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[4] The parties or candidates in the present model are symmetric. They can be thought of as two candidates at an election day when the term limits for the incumbent party have become binding. For models with asymmetric elections where incumbents' choice sets differ from those of the challenger; see e.g. Rogoff and Sibert (1988), Canes-Wrone, Herron, and Shotts (2001) or Hodler, Loertscher, and Rohner (2010).

[5] Perfect information is also assumed by Crawford and Sobel (1982) and Battaglini (2002). The assumption is relaxed by Battaglini (2004).

(2001b).[6]

The paper also relates to the literature on signalling models (for an overview see e.g. Riley, 2001; Sobel, forthcoming). In a standard signalling game such as Spence (1973)'s, types differ with respect to their exogenously given costs in their choice variable. These costs allow them to separate in equilibria satisfying the Intuitive Criterion. In contrast, in the present model there are no such exogenously given costs. Nonetheless signaling can occur in the present model on and off the equilibrium path because depending on the nature of the equilibrium the uncertainty about the other sender's signal can make some actions costlier for one type than for the other.

Bernhardt, Duggan, and Squintani (2007) provide an alternative model that generates policy divergence and that rests on the assumption that parties are uncertain about the median voter's location.[7] Schultz (1996) analyzes a political economy model of information transmission that is complementary to the present study as the parties in his model are mainly (i.e. lexicographically) policy motivated and perfectly informed about the state of the world. The present paper is also close to Heidhues and Lagerlöf (2003) and Laslier and Van Der Straeten (2004), who both analyze information transmission from parties to a voter in setup with two states and two policies.[8] The difference between the two is that Laslier and Van Der Straeten (2004) assume the voter receives an independent signal whereas in Heidhues and Lagerlöf (2003) she does not. Interestingly, in Heidhues and Lagerlöf (2003) a welfare superior equilibrium that involves some information revelation exists if and only if both signals are strong. In this equilibrium voter indifference is achieved through parties' playing mixed strategies upon the signal that indicates the state the voter prefers given the prior. In the present model a fully revealing equilibrium exists if and only if one signal is weak. Despite being fully separating the equilibrium is generically inefficient because the policies that permit separation in equilibrium and keep the voter indifferent are suboptimal from a welfare point of view. In concurrent work, Felgenhauer (2009) analyzes information acquisition and transmission with two and three parties within a setup that otherwise follows Heidhues and Lagerlöf (2003), finding that with two parties parties will remain uninformed in equilibrium. Therefore, the unique equilibrium has

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[6] There is also a mostly very recent literature on models where senders experience a cost of lying; see e.g. Banks (1990), Callander and Wilkie (2007), Kartik, Ottaviani, and Squintani (2007) and Kartik (2009). The difference between these models and the present one is that here messages are costless to parties but costly to the voter because they constrain her choice set.

[7] For empirical evidence on platform divergence, see the references therein.

[8] Within an otherwise similar setup, Canes-Wrone, Herron, and Shotts (2001) study the incentives of an incumbent to pander to the uninformed median voter in order to increase his reelection prospects.

both parties pool at the uninformed voter's bliss point policy. Callander (2008)'s model is related to the present one in that here and there parties' policy proposals serve the dual role of, potentially, conveying information to the voter and of constituting the voter's choice set.[9]

Apart from political competition, the present model applies to any sort of competition between advisors who compete for a client through their advice rather than price or quality. In this vein, the paper that is closest to the present one is Cummins and Nyman (2005), who analyze competition by firms (e.g. managers of investment fonds) for an uninformed customer. In contrast to the parties in my model, the incentives of the firms in Cummins and Nyman (2005) are aligned with those of the client insofar as they also care about the success of the investment. With two firms and binary states and decisions, Cummins and Nyman find that depending on parameters a fully separating equilibrium does not exist, but with an odd or a large number of firms it does.[10] When there is a continuum of heterogenous job candidates the model can also be thought of as a model of hiring based on recommendations by competing experts where the remuneration mechanism is such that an expert gets a fixed payment if and only if the candidate he suggested is hired. Another application of the model is competition between agents whose objective is to win a contest such as a research grant application, a debate, or a court case and who, in order to win, need to convince a referee or a jury whose objective is to pick the party whose proposal is closest to the truth. As the parties who compete for a voter choose locations on a line, the paper also relates and contributes to the literature on Hotelling (1929) location games by adding the twist that locations may reveal information (for references on location games see e.g. Loertscher and Muehlheusser, 2009).

The remainder of this paper is organized as follows. Section 2 introduces the basic model and derives preliminary results, including perfect Bayesian equilibria (PBE). The equilibrium analysis is performed in Section 3. Section 4 provides extensions, and Section 5 concludes. All the proofs are in the appendix.

2 The Model

In this section, I set up the model, derive some preliminary results and introduce the adjustments of otherwise standard refinements to games with two senders and one receiver.

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[9] Less closely but still related are political economy models with experimentation and/or try-and-error politics when decision makers face uncertainty about how the economy functions such as Laslier, Trannoy, and Van Der Straeten (2003), Majumdar and Mukand (2004), Berentsen, Bruegger, and Loertscher (2008), Strulovici (2008) and Callander (2009).

[10] For a related model with pandering toward the consumer's prior, see Gentzkow and Shapiro (2006).

2.1 Setup

Consider the following model of political competition with two parties that are better informed than the single voter. The policy space is $T \equiv [\underline{t}, \bar{t}] \subseteq \mathbb{R}$ and parties 1 and 2 compete by simultaneously announcing platforms $\tau_i \in T$ for $i = 1, 2$, which they are by assumption committed to implement if elected. One way to think of τ is as overall tax burden, zero meaning anarchy and one meaning totalitarianism, in which case $T = [0, 1]$. On the other hand, if τ measures effort or government expenditure, then $T = [0, \infty)$.

Parties solely care for being in office. Parties and the voter are uncertain about which of two possible states $\omega \in \{A, B\}$ is true. Denote by $v(\omega, \tau)$ the voter's utility in state ω when the policy is τ and assume that $v(\omega, \tau)$ is twice differentiable and strictly concave in τ for either state and that the unique maximizer in state A is strictly smaller than in state by B. Letting $\alpha \in (0, 1)$ be the common prior that state A is true, the voter's expected utility is $u(\alpha, \tau) := \alpha v(A, \tau) + (1 - \alpha) v(B, \tau)$. Denote the maximizer of $u(\alpha, \tau)$ by $\tau(\alpha)$. The assumptions on $v(\omega, \tau)$ imply that $\tau(\alpha)$ is unique and monotonically decreases in α.[11] Assume also that for any $\tau \in [\tau(1), \tau(\alpha))$ there is a $\tau' \in T$ with $\tau' > \tau(\alpha)$ such that $u(\alpha, \tau) = u(\alpha, \tau')$ and, analogously, that for any $\tau \in (\tau(\alpha), \tau(0)]$ there is a $\tau^0 \in T$ with $\tau^0 < \tau(\alpha)$ such that $u(\alpha, \tau) = u(\alpha, \tau^0)$. A special case of the present model is the quadratic utility model often used in the cheap talk literature.[12] In state ω the voter's utility is $v(\omega, \tau) = -(\omega - \tau)^2$ when the policy is τ. Letting $A = 0$ and $B = 1$ the expected utility function is thus $u(\alpha, \tau) = -\alpha\tau^2 - (1 - \alpha)(1 - \tau)^2$, yielding $\tau(\alpha) = 1 - \alpha$.[13]

The idea that parties are better informed than the voter is captured in the following way. Each party i receives a private signal $s_i \in \{a, b\}$ indicating, respectively, that state A or B has materialized before choosing its policy τ_i.[14] Conditional on the state, the signal is correct

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[11] The first and second order conditions are $\alpha v'(A, \tau(\alpha)) + (1 - \alpha) v'(B, \tau(\alpha)) = 0$ and $\alpha v''(A, \tau(\alpha)) + (1 - \alpha) v''(B, \tau(\alpha)) < 0$, respectively. Totally differentiating the first order condition and using the second order condition reveals that $\tau'(\alpha) < 0$.

[12] See e.g. Crawford and Sobel (1982) or Krishna and Morgan (2001b).

[13] Under the standard assumptions that all voters update in the same way and that voter preferences are singled peaked, this can be viewed as a shortcut to a model with many voters who differ with respect to some characteristic such as income, where the median voter would be the decisive voter. Let N_V be the number of voters and assume that N_V is odd. Modify the utility function to be $u(\alpha, \tau, \theta_v)$, where θ_v is voter v's type for $v = 1, .., N_V$. Label voters in increasing order, so that $\theta_1 < .. < \theta_{N_V}$. Assuming, as above, $u_2 > 0$ and $u_{22} < 0$, the function has a unique maximizer, denoted $\tau^*(\alpha, \theta_v)$. The sign of $d\tau^*/d\alpha$ and $d\tau^*/d\theta_v$ is the same as that of u_{12} and u_{23}, respectively. So $\tau^*(\alpha, \theta_v)$ will be monotone in α and θ_v if, as is assumed now, u_{12} and u_{23} have constant signs. Consequently, for any belief α, the bliss point policies $\tau^*(\alpha, \theta_1), .., \tau^*(\alpha, \theta_{N_V})$ can be ordered monotonically. Without loss of generality assume $\tau^*(\alpha, \theta_1) < ... < \tau^*(\alpha, \theta_{N_V})$. Under the standard assumption in the literature (see e.g. Callander, 2008) that all voters update in the same manner, the model reduces to the median voter model analyzed here.

[14] Throughout I denote signals with lower case and states with upper case letter. So k is the signal indicating

with probability $1-\varepsilon$ and incorrect with probability ε, where $0 < \varepsilon < 1/2$. For simplicity, assume that signals s_1 and s_2 are independent, conditional on the state.[15] These signals are soft information, so that they cannot be communicated directly to outsiders. All of this is common knowledge.

A pure strategy for party i is a policy τ_i that depends on the private signal s_i. The policy party i plays upon signal $s_i = k$ is denoted τ_i^k with $i = 1, 2$ and $k = a, b$. A natural equilibrium concept is Perfect Bayesian Equilibrium (PBE), and I restrict attention to PBE where the voter's strategy does not depend on the labelling of the parties.[16] That is, denoting by $\gamma(\tau', \tau'')$ the probability that the voter elects party 1 when party 1 plays τ' while 2 plays τ'', the symmetry assumption is that $\gamma(\tau'', \tau') = 1-\gamma(\tau', \tau'')$. Observe that for $\tau' = \tau''$ this implies $\gamma(\tau', \tau'') = 1/2$. Without this assumption, it is easy to construct PBE where the voter elects party 1 with probability one independent of the policy proposals and where both parties play separating strategies. These equilibria are fully revealing but arguably not very compelling as they do not reflect any notion of political competition. Moreover, a large electorate (to which the present model is hopefully a satisfactory shortcut) will typically face problems to coordinate their actions when parties are ex ante identical. For analytical tractability I also focus on equilibria where the parties play pure strategies.

When parties 1 and 2 choose policies τ_1 and τ_2, the voter's posterior belief that A is true is denoted $\mu(\tau_1, \tau_2)$. Some notation for the voter's belief that A is true under the hypothesis that she knew the signal of one or both parties is also useful. In slight abuse of notation let $\mu(a, a)$ and $\mu(b, b)$ be her belief that A is true if both parties have received the signal a and b, respectively. Analogously, let $\mu(a, b) = \mu(b, a)$ be this hypothetical belief when the parties receive divergent signals, and denote by $\mu(a, 0) = \mu(0, a)$ and $\mu(b, 0) = \mu(0, b)$ the belief that A is true under the hypothesis that the voter knows that one party has received the signal a or b, respectively, without knowing the other party's signal, which is denoted by 0. Due to the above assumptions about the signals, it is true that

$$\begin{aligned}\mu(a,a) &= \frac{\alpha(1-\varepsilon)^2}{\alpha(1-\varepsilon)^2+(1-\alpha)\varepsilon^2} > \mu(a,0) = \frac{\alpha(1-\varepsilon)}{\alpha(1-\varepsilon)+(1-\alpha)\varepsilon} > \mu(a,b) = \alpha \qquad (1)\\ &> \mu(b,0) = \frac{\alpha\varepsilon}{\alpha\varepsilon+(1-\alpha)(1-\varepsilon)} > \mu(b,b) = \frac{\alpha\varepsilon^2}{\alpha\varepsilon^2+(1-\alpha)(1-\varepsilon)^2}.\end{aligned}$$

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state K is true with $k \in \{a, b\}$ and $K \in \{A, B\}$.

[15] Signals are said to be independent if conditional on state K party i expects j to get the signal $s_j = k$ with probability $1-\varepsilon$ and the signal $s_j = -k$ with probability ε, independent of the signal s_i i has got, with $k \in \{a, b\}$ and $-k \neq k$.

[16] See also Heidhues and Lagerlöf (2003).

The model is fairly general and permits a variety of interpretations. First, as in Berentsen, Bruegger, and Loertscher (2008) uncertainty may pertain to the shape of the production function for a public good. Second, uncertainty may concern the military or terroristic threat level to which the country is exposed and accordingly to the optimal amount of expenditure on national security. Third, policy may consist of redistributing income via a linear tax when the (median) voter's income is smaller than the average income, and uncertainty may pertain to the shape of the Laffer curve. Observe also that this setup contains Schultz (1996)'s model with respect to policy space and states as a special case, where ω is the cost of production of a public good and τ the expenditure for the public good, so that $u(\alpha,\tau) = F(\tau) - \alpha A - (1-\alpha)B$, where the public good's production function $F(.)$ satisfies Inada conditions and where $A > B > 0$.

2.2 Preliminaries

This subsection first distinguishes between weak and strong signals, which are key to the equilibrium analysis, and then shows that there are different policies that make the voter indifferent. It also shows briefly that there are both many pooling perfect Bayesian equilibria (PBE) and many separating PBE.

Weak and Strong Signals It is useful to distinguish between what can be called weak and strong signals. Denote by $\mu_i(s_j = k \mid s_i = k)$ the probability that party j has received signal $s_j = k$ given that i has received the signal $s_i = k$ with $k = a, b$ and $i \neq j$. Signal k is quite naturally said to be strong if $\mu_i(s_j = k \mid s_i = k) > 1/2$ and said to be weak if $\mu_i(s_j = k \mid s_i = k) < 1/2$.

Lemma 1 *For $\varepsilon < 1 - \alpha$, signal b is strong, while for $\alpha > \varepsilon$, signal a is strong.*

The lemma implies that both signals are strong if and only if $\alpha \in (\varepsilon, 1-\varepsilon)$. Note also that $\mu_i(\omega = K \mid s_i = k) > 1/2$ if and only if k is a strong signal, where $\mu_i(\omega = K \mid s_i = k)$ is the probability that the true state is K when the signal is k. To ease the notation, I sometimes denote $\mu(k \mid k) \equiv \mu_i(s_j = k \mid s_i = k)$. It is also useful to note that $\mu(a|a) > 1 - \mu(b|b)$ for any $(\alpha, \varepsilon) \in (0,1) \times (0, 1/2)$.[17] So as to get an intuition of why the relation between α and ε matters, notice that if $\alpha < \varepsilon$, signal a is more likely to be due to an error: The posterior that

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[17] The formulas for $\mu(k|k)$ with $k = a, b$ are in the proof of Lemma 1 in the appendix. Tedious algebra reveals that $\mu(a|a) - (1 - \mu(b|b) = \frac{(1-alpha)\varepsilon(1-2\varepsilon)^2)}{\alpha(1-\alpha)(1-2\varepsilon)^2+(1-\varepsilon)\varepsilon} > 0$.

$\omega = A$ given $s_i = a$ is $\mu_i(\omega = A|s_i = a) = \frac{(1-\varepsilon)\alpha}{(1-\varepsilon)\alpha+(1-\alpha)\varepsilon}$, which is less than 1/2 since $\alpha < \varepsilon$ implies $(1-\varepsilon)\alpha < (1-\alpha)\varepsilon$.

Indifference Policies The assumptions made above imply that for every $\tau_a < \tau(\alpha)$ close enough to $\tau(\alpha)$ there is a $\tau_b > \tau(\alpha)$ such that

$$u(\alpha, \tau_a) = u(\alpha, \tau_b). \tag{2}$$

As $u(\alpha, \tau)$ is strictly increasing in τ for $\tau < \tau(\alpha)$ and decreasing in τ for $\tau > \tau(\alpha)$, it follows that for all pairs (τ_a, τ_b) satisfying (2) $d\tau_a/d\tau_b < 0$ holds.

Perfect Bayesian Equilibria (PBE) Unsurprisingly the present game exhibits many PBE. I first characterize some general properties of PBE and then show that, among other types of PBE, there is a continuum of pooling PBE and a continuum of separating PBE.

Normalize each party's payoff of winning the election to one and the payoff of losing to zero and denote by $U_i[\tau_i^k \mid s_i = l]$ the expected payoff to i when playing τ_i^k after signal $l \in \{a, b\}$ and when j is presumed to play according to its equilibrium strategy, where τ_i^k is the action equilibrium prescribes i to play upon $s_i = k$. Now by the definition of an equilibrium, the incentive constraint

$$U_i[\tau_i^k \mid s_i = k] \geq U_i[\tau_i^l \mid s_i = k] \tag{3}$$

has to hold in any PBE for else i would be better off playing τ_i^l after signal k than the prescribed action τ_i^k.

Next I state and prove an implication of the assumption that the voter's strategy is symmetric.

Lemma 2 *In any PBE where the voter's strategy is symmetric,*

$$U_i[\tau_i^k \mid s_i = k] = U_j[\tau_j^k \mid s_j = k] = 1/2 \tag{4}$$

for $k \in \{a, b\}$.

I now establish an important property of separating PBE. A PBE is called separating if $\tau_i^a \neq \tau_i^b$ for both $i = 1, 2$.

Lemma 3 $\tau_i^a = \tau_a$ *and* $\tau_i^b = \tau_b$ *for* $i = 1, 2$ *are strategies of a separating PBE only if*

$$u(\alpha, \tau_a) = u(\alpha, \tau_b). \tag{5}$$

Condition (5) is very similar to the arbitrage condition underlying the equilibrium construction in Crawford and Sobel (1982) and Krishna and Morgan (2001b). A subtle but important difference is that here it applies to the voter rather than the parties. Its intuition is clear: Suppose (5) were violated e.g. because $u(\alpha, \tau_a) > u(\alpha, \tau_b)$. Then playing τ_a independently of the signal would be a profitable deviation because it guarantees election with probability 1 if the other party plays τ_b and with probability 1/2 if the other one plays τ_a, so that overall the probability of being elected is greater than 1/2. So for parties to be willing to separate, $u(\alpha, \tau_a) = u(\alpha, \tau_b)$ has to hold. Lemma 3 is important for the results that follow which show that (5) imposes a condition that can be made to hold when one signal is weak but generically not when both signals are strong.

Proposition 1 *There is a continuum of pooling PBE, where* $\tau_i^a = \tau_i^b = \tau$ *for* $i = 1, 2$. *There is also a continuum of separating PBE, where* $\tau_i^a = \tau_a$ *and* $\tau_i^b = \tau_b$ *for* $i = 1, 2$ *and where* τ_a *and* τ_b *satisfy (2).*

The separating PBE arise here because of the continuous strategy space and the concavity properties of $u(\alpha, \tau)$. Proposition 1 is not a complete description of all types of PBE in the model. For example, there are also pooling PBE where one party plays τ_a and the other one τ_b, where τ_a and τ_b satisfy (2), and there may be hybrid PBE where one party does not reveal its signal while the other one does. This raises the question whether some of these PBE are more plausible than others, which is what I address in the next section. Before doing so, it is useful to state and prove the following lemma. Denote by $\tau_a^* \equiv \tau(\mu(a, a))$ and $\tau_b^* \equiv \tau(\mu(b, b))$ the voter's preferred policies if both signals are a and b, respectively.

Lemma 4 *When both signals are strong, there are no separating PBE where* $\tau_a, \tau_b \notin [\tau_a^*, \tau_b^*]$.

Off the equilibrium path the voter's belief about the strategy of the deviating party is not pinned down. However, since a party's strategy is a mapping from signals to policies, there are limits to her beliefs about the state. To see this suppose that party 2 plays $\tau_a < \tau_a^*$ according to equilibrium while party 1 plays an off-the-equilibrium path policy $\tau > \tau_a$. Now the most favorable belief for party 2 is that party 1 played τ if and only if its signal was $s_1 = a$, in which case her belief about the state is $\mu(a, a)$. So by choosing $\tau = \tau(\mu(a, a))$ party 1 has deviation that guarantees election with probability 1, conditional on party 2 receiving signal a and conditional on party 2 playing according to equilibrium. Since both signals are strong, upon signal a party 1 has a posterior exceeding 1/2 that party 2 received the same signal. And since on equilibrium each party wins with probability 1/2 independently of the signal (Lemma 2), the deviation pays off. For very similar reasons, the Intuitive Criterion will impose the tighter constraint that separating equilibrium policies actually satisfy $\tau_a = \tau_a^*$ and $\tau_b = \tau_b^*$ when both signals are strong, as will be shown shortly.

2.3 Refinements

The present model is a sender-receiver game with two senders and one receiver. As standard refinements such as those of Grossman and Perry (1986), Cho and Kreps (1987) and Banks and Sobel (1987) have been formally defined only for sender-receiver games with one sender and one receiver, some adjustments are obviously necessary. The main idea guiding these extensions to games with multiple senders is to focus on one sender, keeping the other sender's strategy fixed according to the equilibrium under consideration and treating the effect this equilibrium strategy may have on the receiver's beliefs as moves by nature. For the purpose of defining and applying the refinements the game is thus transformed from one with two senders and one receiver of known (or fixed) type to a game with one sender facing one receiver who may be of different types. Clearly, the multiplicity of receiver types is only an issue if the equilibrium under investigation prescribes a separating strategy to the other sender for if this other sender's equilibrium strategy is pooling the sender contemplating deviation will correctly infer the receiver's beliefs (i.e. will 'know' them with certainty). Even if the other sender is supposed to play a separating equilibrium strategy the sender who contemplates deviation will 'know' the distribution of receiver types because the probability that the other sender has received the same signal, conditional on his own signal being k, and plays the corresponding equilibrium strategy is given by $\mu(k|k)$. As sender-receiver games with multiple receiver-types are non-standard it is also necessary to be explicit about how the various types of the receiver update. I will impose the hopefully uncontroversial requirement that the receiver holds the same beliefs about the deviating sender's type for each of her possible types.[18]

Intuitive Criterion (CK) The Intuitive Criterion by Cho and Kreps (1987) (CK) can be adapted rather straightforwardly to the present setup. When it is clear which sender (or party) has deviated, the receiver (voter) must put zero probability on that (if any) type of the deviating

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[18] Obviously, keeping the beliefs about the types of the deviating sender fixed implies that the receiver's beliefs about the state of the world will differ depending on her type. As mentioned it is standard to assume that all receivers update in the same way in games with multiple receivers. I am imposing the same requirement on types in a game with multiple types of a single receiver.

sender whose expected equilibrium payoff exceeds the expected payoff from the deviation if the receiver plays a best response for each of her possible types for any beliefs about the deviating sender's type.[19] Equilibria satisfying CK will also be called intuitive.

PSE Grossman and Perry (1986) propose Perfect Sequential Equilibrium (PSE) as a refinement that puts restrictions on the beliefs assigned to types who potentially benefit from a deviation. PSE is very much in the spirit of CK in that it requires the receiver to put zero probability on types for whom an off equilibrium move is dominated by the payoff they get in equilibrium. In addition, PSE requires what Grossman and Perry call credible updating, i.e. to assign prior preserving posterior beliefs to all types who could potentially benefit from the observed deviation. Specifically, in the present model the PSE algorithm works as follows:[20]

First, let $\mathbf{t} = (\tau_1^a, \tau_1^b, \tau_2^a, \tau_2^b)$ be the set of policies that the voter expects to observe with positive probability in a given PBE and assume that she observes a deviation by party 2 to some $\tau_2 \notin \{\tau_2^a, \tau_2^b\}$. Then ask which type(s) - a, b or both - could have benefitted from playing τ_2 rather than the equilibrium policy. Second, assign prior preserving posterior beliefs to all types who could benefit from the deviation. That is, if both types can benefit from this deviation and if μ_a and μ_b denote the priors over these types, then the posterior beliefs $\hat{\mu}_a$ and $\hat{\mu}_b$ must satisfy $\frac{\hat{\mu}_a}{\hat{\mu}_b} = \frac{\mu_a}{\mu_b}$. Third, given these updated beliefs the voter makes the choice that maximizes her expected utility. Fourth, if given this choice by the voter both types of party 2 are no better off than when playing the equilibrium policy, the deviation has not paid off. If both types benefit, the PBE fails the PSE test.[21] Last, for $\mathbf{t}$ to be a set of PSE polices there must be no deviation where at least one type of party 1 or 2 could benefit, assuming that the voter goes subsequently through steps 1 through 4 of this algorithm.

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[19] The assumption implicitly underlying the procedure to identify a deviator is the hypothesis that the minimum number of deviations necessary to generate a given off-the-equilibrium path observation have occurred (see also Bagwell and Ramey, 1991; Emons and Fluet, 2009). So suppose the receiver expects to observe both senders to playing x and y with positive probability but sender 2 playing z with zero probability in a given equilibrium. Then upon observing (x, z) the receiver will identify sender 2 as the deviator. For any $\varepsilon > 0$ it will always be possible to identify the deviator in this manner given that the receiver makes an off-the-equilibrium observation. (If an equilibrium is separating and prescribes playing x upon signal a and y upon b then a sender may deviate to y upon signal a, but this will not be perceived as an off-the-equilibrium observation by the receiver and thus it requires no specification of updating beyond Bayes' rule.)

[20] See Grossman and Perry (1986), Riley (2001) and Hörner and Sahuguet (2007). Schultz (1996) employs a similarly strengthened version of the CK criterion. Farrell (1993)'s neologism-proofness is a closely related concept.

[21] If only one type benefits, then go through the same exercise again, but this time by assigning probability one to the type who could have benefitted. The requirement is then that if probability is assigned only to one type, and if the voter takes her expected utility maximizing action given this belief, the type who is believed to have chosen this policy with probability zero has indeed no incentive to make this deviation.

D1 Cho and Kreps (1987) call an equilibrium D1 if it is robust to deviations where upon a deviation the receiver assigns probability zero to a type who, relative to their equilibrium payoffs, benefits from strictly less mixed strategy best replies by the receiver than another type.[22] The concept translates directly to the (transformed) game in the present model, in which there is only one sender and one receiver. This transformed game is a standard sender-receiver game if the equilibrium under consideration is pooling. If the equilibrium is separating, the only twist is that the receiver will be one of two types the distribution over which is given by the conditional probabilities $\mu(k|k)$ that the other sender has received the same signal as the sender who contemplates deviation. As is standard for Bayesian games, a (mixed or pure) strategy for the receiver is then a complete type-contingent plan.

3 Equilibrium

In this section I show which kinds of equilibria survive which sort of refinements.

3.1 Pooling Equilibria

The first result is a recurring theme within this paper and the broader literature on information transmission, namely that babbling is almost always an equilibrium that cannot be refined away.

In the present model each party i can be of two types, type a after receiving $s_i = a$ or type b upon $s_i = b$. Despite there being only two types, the spirit of the probably most widely used refinement, the intuitive criterion proposed by Cho and Kreps (1987), has no bite vis-à-vis pooling equilibria. To see why, consider any pooling PBE described in Proposition 1. Though some of these rest on beliefs that are not very plausible, no equilibrium policy is dominated by equilibrium payoffs because on equilibrium every party is elected with probability 1/2 and could hence benefit if, after an off equilibrium move, it were elected with a larger probability.[23]

Proposition 2 *For any $\alpha \in (0,1)$, there is a continuum of pooling equilibria that satisfy CK and D1. For any $\alpha \in (0,1)$ there is a unique pooling PSE, whose outcome is $\tau(\alpha)$.*

Observe first that if the voter elects the deviator with probability one both types of a party potentially benefit from a deviation. Thus, the off equilibrium belief consistent satisfying the

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[22] See also Banks and Sobel (1987) or Sobel (forthcoming).

[23] In contrast to the beer-quiche game of Cho and Kreps (1987) there is no PBE where a type gets his first-best (quiche and no fight or beer and no fight) in the present model.

constraints imposed by PSE is $\mu = \alpha$. To see that no $\tau \neq \tau(\alpha)$ is a pooling PSE outcome, assume without loss of generality that $\tau < \tau(\alpha)$. Because $u(\alpha, \tau)$ has a unique maximum, which is achieved with $\tau(\alpha)$, the voter will prefer any $\tau' \in (\tau, \tau(\alpha)]$ to the proposed equilibrium policy. Hence, there are profitable deviations satisfying the restriction on updating imposed by PSE. Thus no $\tau \neq \tau(\alpha)$ can be a pooling PSE outcome. To see that $\tau(\alpha)$ is a pooling PSE outcome, it suffices to notice that the voter will strictly prefer $\tau(\alpha)$ to any other policy as long as her beliefs are α, which as just argued they will be both on and off the equilibrium path.

3.2 Separating Equilibria

Next consider separating equilibria.

Strong signals. A corollary to Lemma 3 is that $\tau_i^a = \tau_a$ and $\tau_i^b = \tau_b$ for $i = 1, 2$ are strategies in a separating intuitive equilibrium only if (5) holds. In addition, CK imposes the following restriction on separating equilibria:

Lemma 5 *If both signals are strong, $\tau_i^a = \tau_a$ and $\tau_i^a = \tau_b$ for $i = 1, 2$ are strategies of a separating intuitive equilibrium only if*

$$\tau_a = \tau_a^* \quad \textit{and} \quad \tau_b = \tau_b^*. \tag{6}$$

The lemma is key. It adds a second condition on equilibrium policies when both signals are strong that will generically not hold simultaneously with condition (5). Figure 1 illustrates the generic case. The black and red curve depict, respectively, $u(\mu(a, a), \tau)$ and $u(\mu(b, b), \tau)$. The blue curve is $u(\alpha, \tau)$. Generically, $u(\alpha, \tau_a^*) \neq u(\alpha, \tau_b^*)$ will be the case. The non-generic case is illustrated in Figure 2.

Upon getting signal k a party's belief that the other party has got the same signal, $\mu(k \mid k)$, exceeds 1/2 if signal k is strong. If it plays on equilibrium, it wins with probability 1/2 (Lemma 2). Therefore, a deviation that guarantees victory if the other party has received the same signal will be profitable since its expected payoff is at least $\mu(k \mid k) > 1/2$. Now if both signals are strong, and if the deviation leads to election if and only if the other party has got the same signal k, then upon getting the signal $l \neq k$ the other party has indeed no incentive to play this deviation as it guarantees victory only with probability $1 - \mu(l \mid l) < 1/2$. Therefore, starting from a candidate separating equilibrium a deviator can credibly convey its signal by choosing such a policy, and benefit from the deviation. Unless, that is, the prescribed equilibrium policy

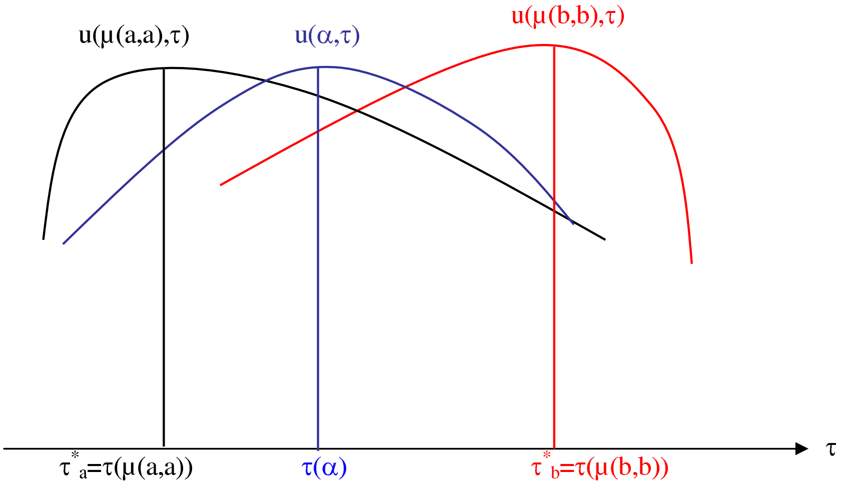

Figure 1: PSE Conditions: The generic case.

upon signal k is τ_k^*. To see that the deviation leads to election iff the other party has received the same signal, recall from Lemma 4 that no separating PBE policies $\tau_a, \tau_b \notin [\tau_a^*, \tau_b^*]$ exist. Therefore, the policies of a candidate separating intuitive equilibrium will be between τ_a^* and τ_b^* and satisfy $u(\alpha, \tau_a) = u(\alpha, \tau_b)$. Suppose $\tau_a, \tau_b \in (\tau_a^*, \tau_b^*)$. Now, if only, say, type a of a party benefits from the deviation to τ_a^*, then upon observing (τ_a^*, τ_b) the voter will prefer τ_b since her belief will be α. (And if she believes that both types of the deviating party have played τ_a^* with positive probability her belief that the state is A will be even less than α and she will prefer τ_b a fortiori.) However, upon observing (τ_a^*, τ_a) the voter will prefer τ_a^* if she assigns probability 0 to the deviation τ_a^* coming from type b. When both signals are strong, the probability that the other party has received the same signal exceeds 1/2 for both signals. Since on the equilibrium path each party wins with probability 1/2 independently of the signal (Lemma 2), the deviation to τ_a^* pays off for the party with signal a and not for the party with signal b. Moreover, since exactly the same logic applies for the policies upon signal b, the policies in a separating intuitive equilibrium must be τ_a^* upon signal a and τ_b^* upon signal b. But since generically $u(\alpha, \tau_a^*) \neq u(\alpha, \tau_b^*)$ will hold, the next proposition follows:

Proposition 3 *If both signals are strong, there is generically no separating equilibrium that satisfies CK.*

This proposition has the following corollary:

Corollary 1 *If both signals are strong, the generically unique PSE outcome is* $\tau(\alpha)$.

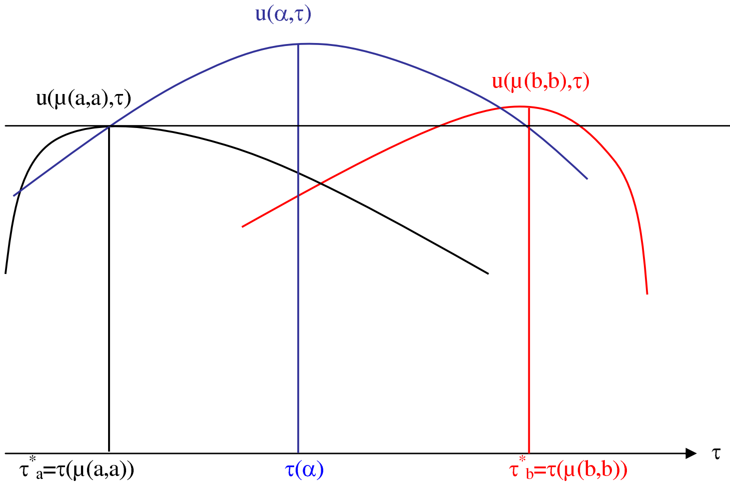

Figure 2: PSE Conditions: The non-generic case.

Non-generic separating intuitive equilibria when both signals are strong may exist if by a fluke it so happens that $u(\alpha, \tau_a^*) = u(\alpha, \tau_b^*)$.[24] Interestingly, in the present model the CK criterion has bite for separating equilibria but not for pooling equilibria.

An implication of Proposition 3 is that as signals become arbitrarily precise (that is, as ε goes to 0), generically no information will be transmitted in any intuitive equilibrium. This will appear counterintuitive. However, the reason for this failure to transmit very precise information is not that the voter trusts the parties too little as their signals become very accurate. Rather, parties trust their source of information too much for a separating intuitive equilibrium to be supported: Since both signals are strong, party i believes with probability larger than 1/2 that party j has received the same signal upon receiving $s_i = a$ or $s_i = b$. In order for i not to deviate from the prescribed policy τ_a (or τ_b) it must be the case that $\tau_a = \tau_a^*$ (and $\tau_b = \tau_b^*$). But generically, $u(\alpha, \tau_a^*) \neq u(\alpha, \tau_b^*)$ will be the case. As ε goes to zero the interval $(\varepsilon, 1-\varepsilon)$ coincides with $(0,1)$. Consequently, as signals become perfectly accurate, both signals are strong for any interior prior.

Weak signal. If one signal is weak, there are generic separating PSE. Let $\hat{\tau}_k \equiv \arg\max_\tau u(\mu(k,0),\tau)$ with $k \in \{a,b\}$. That is, $\hat{\tau}_k = \tau(\mu(k,0))$. Observe that $\hat{\tau}_k$ maximizes the voter's expected utility if she knows or correctly infers that one party has received the signal k while the other party's signal is not known.

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[24] In addition, for there to be a separating PSE there must be no $\tau \in (\tau_a^*, \tau_b^*)$ such that $u(\mu(a,0),\tau) > u(\mu(a,0),\tau_a^*)$ and $u(\mu(b,0),\tau) > u(\mu(b,0),\tau_b^*)$. The conditions under which this holds are somewhat obscure.

Proposition 4 *If one signal is weak, then there are separating equilibria satisfying CK and there is a unique separating PSE that is generic. The PSE policies are as follows. If* b *is the weak signal, party* $i = 1, 2$ *sets* $\hat{\tau}_a$ *if* $s_i = a$ *and* τ_b *if* $s_i = b$*, where* $u(\alpha, \hat{\tau}_a) = u(\alpha, \tau_b)$*. If* a *is the weak signal, party* $i = 1, 2$ *sets* $\hat{\tau}_b$ *if* $s_i = b$ *and* τ_a *if* $s_i = a$*, where* $u(\alpha, \tau_a) = u(\alpha, \hat{\tau}_b)$*.*

Thus, despite the fact that parties are purely office motivated, the model exhibits a generic separating intuitive equilibria if one signal is weak. The construction of the unique PSE relies first, as any separating PBE, on an indifference condition of the voter in case the parties disagree and second on the fact that upon receiving the weak signal k a party has no incentive to deviate to τ_k^* if the equilibrium prescribes playing $\tau_k \neq \tau_k^*$. This is so because upon getting the weak signal the party believes with probability less than 1/2 that the other party has received the same signal. Therefore, it is not willing to take the gamble of defeating the opponent only in the event it has got the same signal, which is not sufficiently likely. In contrast, upon either signal both parties would have incentives to take the gamble of defeating the opponent with certainty only in the event that the opponent has received the strong signal. Therefore, the equilibrium must prescribe to play $\hat{\tau}_l$ upon $s_i = l$ if l is the strong signal.

Despite the fact that ex ante parties are identical and are, per se, willing to propose any policy if that increases the chances of being elected, the model exhibits endogenous signalling costs. This contrasts with standard signalling games such as Spence's education model, where types differ with respect to their exogenously given costs of education, which allows them to separate in an intuitive equilibrium. Separation can occur here because some deviations become too costly in equilibrium, given a party's probability assessment about the other party's signal and hence action.

It is also worth noting that if one signal is weak there generically also exists a separating equilibrium that satisfies D1. This equilibrium is qualitatively very similar to the PSE described in Proposition 4. However, because D1 constrains off equilibrium updating in somewhat different ways than PSE the policies in a separating D1 equilibrium are τ_k^* upon the strong signal k and the $\tau \neq \tau_k^*$ that solves $u(\alpha, \tau_k^*) = u(\alpha, \tau)$ upon the weak signal. The proof is in Appendix B. The difference in a nutshell is that PSE imposes prior preserving beliefs for any deviation that is interpreted as pooling (i.e. as being profitable for both sender types), which imposes the restriction $\tau_k = \tau(\mu(k, 0))$ for the equilibrium policy upon the strong signal k. Under D1 deviations $\tau \in (\tau_a, \tau_b)$ are also interpreted as pooling but without imposing restrictions on the receiver's beliefs. In contrast, however, if signal a is strong and $\tau_a > \tau_a^*$, then deviations below but not too far away from τ_a will be interpreted as coming from the sender with signal a only (essentially because $\mu(a|a) > 1 - \mu(b|b)$), which leads to the restriction $\tau_a = \tau_a^*$ for τ_a to be an equilibrium policy.

4 Extensions

In this section I consider, in turn, the following extensions. First, I analyze the model when parties can send cheap talk messages in addition to proposing policies. Second, I study the model when parties determine their policies sequentially rather than simultaneously. Third, I introduce a status quo policy. Fourth, I allow for the possibility that once in office parties are not committed with probability one to implement the polices they propose during the campaign. Last I briefly perform some welfare analysis for the specification with quadratic utility.

4.1 Cheap Talk Augmented Model

So far parties could only communicate through their policy proposals. An interesting and important question is whether the results obtained under these assumptions are robust to the introduction of alternative means of communication. Specifically consider now the following cheap talk augmented model where upon observing its signal s_i each party i chooses a policy τ_i and sends a message m_i to the voter. Thus, letting $p_i = (\tau_i, m_i)$ be the platform of party i, the voter observes a pair (p_1, p_2), updates her beliefs and then chooses the party whose policy τ_i maximizes her expected utility given her thus updated beliefs. To maintain comparability with the results derived above assume as before that parties play pure strategies and that the voter plays a symmetric strategy. That is, when the platforms proposed by party 1 and 2 are p' and p'' the voter elects party 1 with the same probability as she elects party 2 when the platforms of party 1 and 2 are p'' and p', respectively.

Given the restriction to symmetric voter strategies, it still holds that in equilibrium, conditional on either signal, each party is elected with probability 1/2. Consequently, the same indifference requirements on separating equilibrium platform must hold as have to hold for separating equilibrium policies in the game without cheap talk messages. That is, $u(\alpha, \tau_a) = u(\alpha, \tau_b)$ has to hold, where τ_k is the policy equilibrium prescribes to set upon signal k, $k = a, b$. When both signals are strong and the candidate equilibrium is separating, deviations generically exist that are equilibrium payoff dominated for one type of a party but not for the other one. Consequently, with strong signals there are generically no separating intuitive equilibria. However, such equilibria exist when one signal is weak.

Consider equilibrium policies τ_a^{eq}, τ_b^{eq} in a game without messages and notice that in the game with messages a deviation from a prescribed equilibrium platform $(\overline{\tau}_k, \overline{m}_k)$ can be one of three things: (i) $(\overline{\tau}_k, m_k)$, (ii) $(\tau_k, \overline{m}_k)$ or (iii) (τ_k, m_k). Distinguishing deviations along this line proves helpful since, almost trivially, deviations of type (ii) and (iii) make no difference relative to a model without messages: Whatever the deviator manages to signal/convey with $(\tau_k, \overline{m}_k)$ or (τ_k, m_k) can be signalled with τ_k in the baseline model. Therefore the only channel through which a difference between the two models can arise is via (i).

Now starting from pooling equilibria it is (almost) immediate that the set of pooling equilibrium policies satisfying a given refinement cannot differ from the model with cheap talk messages to the one without: The voter will still be indifferent between the two parties policies given that they offer the same policies even after the deviation (i).

Things are slightly trickier for separating equilibria because now a priori a deviation of type (i) can pay off if it manages to affect the voter's beliefs. Suppose that we are in a separating equilibrium and that the deviation $(\overline{\tau}_a, m_a)$ shifts the beliefs in favor of A if the other party plays the equilibrium policy prescribed for type b. Then the deviation would pay off since it guarantees victory in case of diverging signals and a tie in case both get signal a. But notice now that such belief targeting/shaping is not possible because the voter already correctly infers in equilibrium that the deviating party has received the signal a. In this case she is indifferent between $\overline{\tau}_a$ and $\overline{\tau}_b$ if the other party played $(\overline{\tau}_b, \overline{m}_b)$. Thus, the set of separating equilibrium policies satisfying a given refinement will not differ between the two models either.[25]

4.2 Sequential Moves

Though assuming simultaneously moving parties may be preferable to assuming sequential moves because it presumes less detailed knowledge on behalf of the modeler, it is worth investigating what happens if parties move sequentially, not least because this alternative is considered e.g. by Krishna and Morgan (2001b,a) and Pesendorfer and Wolinsky (2003). Throughout this subsection assume party 1 moves first and party 2 second.

In general the assumption that senders move sequentially will add the complication that a refinement needs to spell out both how the second sender and how the receiver update their

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[25] This result may hinge on the assumption that signals are binary so that their strength cannot be communicated more subtly simply because signals are not more or less nuanced.

beliefs. However, in the present model any sender's payoff is not directly affected by his own beliefs (or those of the other sender) but only depends on the action the receiver takes, given her beliefs.[26] In any equilibrium the second sender will correctly anticipate the receiver's beliefs both on the equilibrium path and after a deviation by sender 1 only. Therefore we can safely neglect how party 2 updates its beliefs, so that we only need to be concerned about how the voter updates her beliefs. Thus, the definitions of CK, D1 and PSE, appropriately adjusted to games with multiple senders, can be directly applied to the game with sequentially moving senders.

The set of pooling equilibrium outcomes is not affected by introducing sequential moves, where an equilibrium is said to be pooling if and only if both parties play the same policy independently of their signals.

Proposition 5 *Any* $\tau \in [\tau(\mu(a,a)), \tau(\mu(b,b))]$ *is the outcome of a pooling equilibrium satisfying CK and D1 with sequential moves, and no other policy is the outcome of a pooling equilibrium. The unique pooling PSE outcome with sequential moves is* $\tau(\alpha)$.

Another question is whether there are fully separating PSE with sequential moves, i.e. PSE where both players' signals are revealed on the equilibrium path. The answer is affirmative:

Proposition 6 *With sequential moves, there are generic fully separating PSE for any* $\alpha \in (0,1)$ *and* $\varepsilon \in (0,1/2)$.

In contrast to the model with simultaneous moves any deviation by any player would be pooling with sequential moves under the PSE refinement. Deviations from the actions prescribed by the separating equilibrium by party 2 can be preempted by 1 by playing $\hat{\tau}_k$ upon signal $k = a, b$, which cannot be defeated by a pooling deviant. Deviations by party 1 can be countered by party 2 by playing $\tau(\alpha)$, which is the optimal policy given pooling behavior.

A consequence of the fact that with sequential moves all deviations are pooling is that, unlike with simultaneous moves, a separating equilibrium policy does not have to satisfy τ_k^* if signals are strong. The reason is that the endogenous signalling costs disappear for party 2 who, assuming equilibrium play by 1, is now certain about 1's signal. Therefore, it cannot credibly reveal its signal by off equilibrium behavior.

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[26] Notice the difference to the game where parties move simultaneously. There each party's beliefs matter because, depending on the equilibrium, these beliefs can be informative (in a stochastic sense) about the action the other party takes and therefore about the beliefs of the voter.

The difference to Krishna and Morgan (2001b) is interesting and quite striking. They find that there are fully separating PBE with simultaneous moves but not with sequential moves. For the case where both signals are strong (which corresponds to the case analyzed by Krishna and Morgan who focus on perfectly informed parties), the opposite result obtains in the present paper.

4.3 Status Quo Policy

As in (parts of) Krishna and Morgan (2001a) and Gilligan and Krehbiel (1989) assume there is a status quo policy τ^O the voter can threaten to choose. This status quo policy can also be interpreted as the preferred and state independent policy proposed by a third party, which would for instance be the case if the third party is ideological and does either not receive a signal or is known to ignore it. Like in the baseline model parties are again assumed to move simultaneously.

Proposition 7 $\tau(\alpha)$ *is still the unique pooling PSE outcome.*

Another, and perhaps more interesting or relevant question is whether there are separating PSE once the voter has an outside option.

Proposition 8 *If both signals are strong and* $\tau^O \notin [\tau_a^*, \tau_b^*]$*, then there is generically no separating equilibrium satisfying CK.*

In a model with binary states, signals and policies, Felgenhauer (2009) analyzes the effect of adding a third, populist party that always chooses the uninformed voter's preferred policy and shows that a fully informative equilibrium exists. Interpreting the status quo policy τ^O as the policy proposal by a third party, Proposition 8 complements Felgenhauer's findings by showing that if the third party is not a populist (like, say, Ralph Nader), then it has no effect on the informativeness of the equilibrium policies.

4.4 Imperfectly Committed Parties

So far parties have been assumed to somewhat stubbornly implement the policies with which they campaign. This assumption is now relaxed by assuming that each party can a priori be one of two types or qualities $q \in \{C, O\}$. These qualities matter in the following sense. A party of quality C is *committed* to implement the policy it proposed during the campaign. A party of quality O is *opportunistic* and willing to deviate from the policy it announced in the election campaign. I assume that if of quality O either party implements the policy that maximizes the voter's expected utility given the information the party has once it is in office.[27] Notice that parties of quality C are the parties studied hitherto. A party's quality is its private information, and the probability that $q = C$ is $\beta > 0$, so that the probability of being $q = O$ is $1 - \beta$.[28] Quality is independent across parties and independent of the signals. Regardless of its quality,[29] each party still cares exclusively about winning the election. All the other assumptions are as in the baseline model.

Lemma 6 *Party quality $q \in \{O, C\}$ cannot be signalled in equilibrium.*

Assume now that upon being in office a party learns the other party's signal regardless of the action chosen. This assumption certainly simplifies the analysis. An alternative that remains to be explored is that a party in office only knows its own signal for sure and, depending on the equilibrium, may or may not infer the other party's signal. Given this simplifying assumption, upon being in office both parties implement the same policy with probability β. Though the voter does not necessarily know what this policy is, the parties do not differ in that respect if they are of quality O, and the voter need not worry since the policy will maximize her expected utility. So parties and their proposals only matter if they are of quality C. Therefore, every equilibrium is completely driven by C-types. But this is the model already studied above. Consequently:

Proposition 9 *Equilibrium policies do not vary with $\beta \in (0, 1]$.*

The proposition implies that whatever is an equilibrium outcome in the model with $\beta = 1$ is an equilibrium outcome for any $\beta \in (0, 1)$ for any given refinement. Thus, whether or not parties are fully committed to implement the policies they propose does not affect equilibrium behavior. The limit case with $\beta = 0$, where both parties are opportunistic, is excluded from the proposition because it gives rise to a continuum of equilibrium outcomes even under the PSE refinement: As both parties implement the same policy with probability 1 upon being elected, their policy proposals do not matter. Therefore, equilibrium is indeterminate. With $\beta > 0$, C-types imitate O-types in any pure strategy PBE. Therefore, the presence of O-types has no impact on the policies proposed in equilibrium. Still, their presence matters as it obviously

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[27] Therefore, the labels "committed" and "opportunistic" are slight misnomers.

[28] Notice that the model analyzed so far corresponds to the special case with $\beta = 1$ of the model sketched here.

[29] Notice that after receiving its signal s_i and before choosing its policy τ_i party i can now be one of four types in $\{C, O\} \times \{a, b\}$.

improves the voter's expected welfare because it improves the expected quality of policies that are ultimately implemented.

4.5 Welfare with Quadratic Utility

Another interesting question is whether expected voter welfare is indeed larger in the separating PSE, as one would naturally conjecture. The expected welfare of the voter in the pooling PSE is $W^{pool} = u(\alpha, \tau(\alpha))$. Absent an outside option such as a status quo policy, voter welfare is the appropriate welfare measure as one of the two parties is chosen with probability one. Her expected welfare in a separating PSE with equilibrium policies τ_a and τ_b is[30]

$$W^{sep} = [u(1,\tau_a)\alpha + u(0,\tau_b)(1-\alpha)](1-\varepsilon) + [u(0,\tau_a)(1-\alpha) + u(1,\tau_b)\alpha]\varepsilon. \tag{7}$$

How W^{pool} and W^{sep} compare is hard to say in general as the comparison depends both on the intricate properties of the utility function $u(.)$ and on the signal technology. To simplify, assume therefore that utility is quadratic with $u(\alpha,\tau) = -\alpha\tau^2 - (1-\alpha)(1-\tau)^2$. Since $\tau(\alpha) = 1-\alpha$, $W^{pool} = -\alpha(1-\alpha)$. Without loss of generality, assume that signal a is strong and signal b is weak, so that a separating PSE exists for all $\alpha > 1-\varepsilon$. The equilibrium policies are $\tau_a = \tau(\mu(a,0))$ and the $\tau_b \neq \tau_a$ that solves $u(\alpha, \tau(\mu(a,0))) = u(\alpha,\tau_b)$, yielding $\tau_a = 1-\mu(a,0)$ and $\tau_b = 1 - 2\alpha + \mu(a,0)$. So the ex ante expected welfare in the separating PSE is

$$W^{sep} = -(1-\varepsilon)[\alpha(1-\mu(a,0))^2+(1-\alpha)(-\mu(a,0)+2\alpha)^2]-\varepsilon[\alpha(\mu(a,0)-2\alpha+1)^2+(1-\alpha)\mu(a,0)^2]. \tag{8}$$

Tedious algebra reveals that $W^{sep} > W^{pool}$ for all $\alpha > \frac{1-4\varepsilon}{4(1-2\varepsilon)}$, which is strictly less than $1-\varepsilon$ for all $\varepsilon < 1/2$. Thus, whenever a generic separating PSE exists, it generates higher welfare than the pooling PSE. Among other things, this implies that in the neighborhoods of $\alpha = 1-\varepsilon$ and $\alpha = \varepsilon$ the voter would actually prefer parties to be less well informed because that induces them to play the separating PSE (assuming that the welfare superior equilibrium is played in case of multiple equilibria). Still under the same equilibrium selection hypothesis, the model predicts that one should observe policy divergence only if ε is relatively large. In this case the probability that the parties' policy proposals diverge is $2(1-\varepsilon)\varepsilon$, which is strictly larger than ε.[31]

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[30] To see that this is true, notice that $W^{sep} = \alpha(1-\varepsilon)^2u(1,\tau_a) + (1-\alpha)(1-\varepsilon)^2u(0,\tau_b) + \alpha(1-\varepsilon)\varepsilon[u(1,\tau_a) + u(1,\tau_b)] + (1-\alpha)(1-\varepsilon)\varepsilon[u(0,\tau_a) + u(0,\tau_b)] + \alpha\varepsilon^2u(1,\tau_b) + (1-\alpha)\varepsilon^2u(0,\tau_a)$. This simplifies to the expression in (7).

[31] For example, at $\varepsilon = 1/3$, the probability of divergence is 4/9. At $\varepsilon = 1/10$, the probability of divergence is still close to 1/5.

5 Conclusions

The empirical content of the theory proposed in this paper is that one should observe policy convergence in policy areas where political expertise is advanced (ε small) while policy can diverge if parties' expertise is moderate or limited. This is fairly intuitive as it seems natural to expect more variance in opinions, and accordingly in policy proposals, when expertise is moderate. The subtle twist here is that with excellent expertise policy converges to an uninformative, conventional wisdom type of policy that does not vary with the available information.Thus, parties appear to be experimenting when uncertainty is significant but not when they are almost certain what the truth is. One way to test this empirically would be to examine whether the electorate's policy preferences differ before and after parties formulate their policies and depending on whether these areas are characterized by excellent or moderate expertise.

Wittman (1989) has argued forcefully that political competition would result in efficient political outcomes. The present paper provides a model where political competition cannot be relied upon to generate efficient outcomes. Callander (2008, p.680) notes that "standard intuition about the median voter theorem doesn't extend to incomplete information environments." To the extent that there is another non-Downsian equilibrium whenever one signal is weak the present paper corroborates Callander's findings. However, as parties' signals become very precise, the generically unique equilibrium involves pooling at the voter's uninformed bliss point policy, which corresponds to the median voter theorem.

Two important and related questions are whether parties would choose high or low levels of expertise in equilibrium and whether they would choose identical or different levels of expertise if they were given the opportunity to choose their expertise in a first stage preceding the game analyzed as the baseline model of the present paper. Under the assumptions that voters can play asymmetric strategies if and only if parties differ with respect to their expertise and that for reasons that remain to be modeled voters prefer all else equal parties with higher expertise, a natural conjecture would be that Bertrand-type of competition between parties will induce them to choose the maximum (and hence identical) level of expertise, whereby the parameter set for which informative intuitive equilibria exist will be minimized. Showing this rigorously requires showing that when parties are heterogenous no intuitive separating equilibria exist (or if this fails, that no separating PSE exist) where the party with less expertise is elected with a probability of a half, assuming that in the presence of pooling and separating equilibria the latter are selected. This exercise is left for future research.

Appendix

A Proofs

Proof of Lemma 1: Upon observing $s_i = a$ party i's belief that A is true is $\mu_i(\omega = A \mid s_i = a) = \frac{\alpha(1-\varepsilon)}{\alpha(1-\varepsilon)+(1-\alpha)\varepsilon}$ and, consequently, i's belief that B is true given $s_i = a$ is $\mu_i(\omega = B \mid s_i = a) = \frac{(1-\alpha)\varepsilon}{\alpha(1-\varepsilon)+(1-\alpha)\varepsilon}$. So conditional on signal $s_i = a$ i's belief that j's signal is $s_j = a$ is $\mu_i(s_j = a \mid s_i = a) = \mu_i(\omega = A \mid s_i = a)(1-\varepsilon) + \mu_i(\omega = B \mid s_i = a)\varepsilon = \frac{\alpha(1-\varepsilon)^2+(1-\alpha)\varepsilon^2}{\alpha(1-\varepsilon)+(1-\alpha)\varepsilon}$ and conditional on signal $s_i = b$ i's belief that $s_j = b$ is $\mu_i(s_j = b \mid s_i = b) = \frac{\alpha\varepsilon^2+(1-\alpha)(1-\varepsilon)^2}{\alpha\varepsilon+(1-\alpha)(1-\varepsilon)}$. To see that $\mu_i(s_j = a \mid s_i = a) > \frac{1}{2}$ if and only if $\alpha > \varepsilon$ and $\mu_i(s_j = a \mid s_i = a) > \frac{1}{2}$ if and only if $\alpha < 1-\varepsilon$, notice that $\mu_i(s_j = a \mid s_i = a) = 1/2$ at $\alpha = \varepsilon$ and $\mu_i(s_j = a \mid s_i = a)$ is increasing in α for all $\varepsilon < 1/2$. Similarly, $\mu_i(s_j = b \mid s_i = b)$ decreases in α and equals $1/2$ at $\alpha = 1-\varepsilon$. ■

Proof of Lemma 2: I first show that $U_1[\tau_1^k \mid s_1 = k] + U_2[\tau_2^k \mid s_2 = k] = 1$ for both $k = a, b$. Once this is established, the lemma follows rather straightforwardly because of the assumption that the voter's strategy is symmetric.

Denoting by $\gamma(\tau_1, \tau_2)$ the probability that the voter elects party 1 if 1 plays τ_1 and 2 plays τ_2, So

$$\begin{aligned}
U_1[\tau_1^a \mid s_1 = a] &= \mu_1(s_2 = a \mid s_1 = a)\gamma(\tau_1^a, \tau_2^a) + (1 - \mu_1(s_2 = a \mid s_1 = a))\gamma(\tau_1^a, \tau_2^b) \\
U_2[\tau_2^a \mid s_2 = a] &= \mu_2(s_1 = a \mid s_2 = a)(1 - \gamma(\tau_1^a, \tau_2^a)) + (1 - \mu_2(s_1 = a \mid s_2 = a))(1 - \gamma(\tau_1^b, \tau_2^a)) \\
U_1[\tau_1^b \mid s_1 = b] &= \mu_1(s_2 = b \mid s_1 = b)\gamma(\tau_1^b, \tau_2^b) + (1 - \mu_1(s_2 = b \mid s_1 = b))\gamma(\tau_1^b, \tau_2^a) \\
U_2[\tau_2^b \mid s_2 = b] &= \mu_2(s_1 = b \mid s_2 = b)(1 - \gamma(\tau_1^b, \tau_2^b)) \\
&+ (1 - \mu_2(s_1 = b \mid s_2 = b))(1 - \gamma(\tau_1^a, \tau_2^b)).
\end{aligned}$$

Notice that $\mu_1(s_2 = k \mid s_1 = k) = \mu_2(s_1 = k \mid s_2 = k)$ for $k = a, b$. To simplify notation, I write $\theta_k \equiv \mu_1(s_2 = k \mid s_1 = k)$, $x \equiv \gamma(\tau_1^a, \tau_2^a)$, $y \equiv \gamma(\tau_1^a, \tau_2^b)$, $c \equiv 1 - \gamma(\tau_1^b, \tau_2^a)$ and $d \equiv \gamma(\tau_1^b, \tau_2^b)$.

The incentive constraints (3) can now be written as

$$\begin{aligned} U_1[\tau_1^a \mid s_1 = a] = \theta_a x + (1-\theta_a)y &\geq \theta_a(1-c) + (1-\theta_a)d \\ &= U_1[\tau_1^b \mid s_1 = a] \qquad (9) \\ U_2[\tau_2^a \mid s_2 = a] = \theta_a(1-x) + (1-\theta_a)c &\geq \theta_a(1-y) + (1-\theta_a)(1-d) \\ &= U_2[\tau_2^b \mid s_2 = a] \qquad (10) \\ U_1[\tau_1^b \mid s_1 = b] = \theta_b d + (1-\theta_b)(1-c) &\geq \theta_b y + (1-\theta_b)x \\ &= U_1[\tau_1^a \mid s_1 = b] \qquad (11) \\ U_2[\tau_2^b \mid s_2 = b] = \theta_b(1-d) + (1-\theta_b)(1-y) &\geq \theta_b c + (1-\theta_b)(1-x) \\ &= U_2[\tau_2^a \mid s_2 = b]. \qquad (12) \end{aligned}$$

Adding (9) and (10) yields $1 \leq y + c$ while adding (11) and (12) implies $1 \geq y + c$. Thus, $y + c = 1$ holds.

Now,

$$U_1[\tau_1^a \mid s_1 = a] + U_2[\tau_2^a \mid s_2 = a] = \theta_a + (1-\theta_a)(y+c) = 1 \qquad (13)$$

and

$$U_1[\tau_1^b \mid s_1 = b] + U_2[\tau_2^b \mid s_2 = b] = \theta_b + (1-\theta_b)(2-(y+c)) = 1, \qquad (14)$$

where the second equalities hold because $y+c = 1$. Thus, the first part of the proof is complete.

To see that the first equality in (4) holds, suppose to the contrary that it does not. Without loss of generality, assume $U_1[\tau_1^a \mid s_1 = a] < U_2[\tau_2^a \mid s_2 = a]$. Since $U_1[\tau_1^a \mid s_1 = a] + U_2[\tau_2^a \mid s_2 = a] = 1$, this implies $U_1[\tau_1^a \mid s_1 = a] < 1/2$. But now, upon $s_1 = a$ party 1 could play τ_2^a instead of the prescription τ_1^a, in which case it would get

$$U_1[\tau_2^a \mid s_1 = a] = \theta_a \gamma(\tau_2^a, \tau_2^a) + (1-\theta_a)\gamma(\tau_2^a, \tau_2^b), \qquad (15)$$

or τ_2^b, in which case it would get

$$U_1[\tau_2^b \mid s_1 = a] = \theta_a \gamma(\tau_2^b, \tau_2^a) + (1-\theta_a)\gamma(\tau_2^b, \tau_2^b). \qquad (16)$$

Due to the assumption that the voter's strategy must not depend on the parties' labels, $\gamma(\tau_2^a, \tau_2^a) = \gamma(\tau_2^b, \tau_2^b) = \frac{1}{2}$ and $\gamma(\tau_2^b, \tau_2^a) = 1 - \gamma(\tau_2^a, \tau_2^b)$. Thus, these two equations simplify to

$$U_1[\tau_2^a \mid s_1 = a] = \theta_a \frac{1}{2} + (1-\theta_a)\gamma(\tau_2^a, \tau_2^b) = \gamma(\tau_2^a, \tau_2^b) + \theta_a \left(\frac{1}{2} - \gamma(\tau_2^a, \tau_2^b)\right) \qquad (17)$$

and

$$U_1[\tau_2^b \mid s_1 = a] = \theta_a(1 - \gamma(\tau_2^a, \tau_2^b)) + (1 - \theta_a)\frac{1}{2} = \frac{1}{2} + \theta_a\left(\frac{1}{2} - \gamma(\tau_2^a, \tau_2^b)\right). \tag{18}$$

The expression in (17) weakly exceeds 1/2 if $\gamma(\tau_2^a, \tau_2^b) \geq \frac{1}{2}$ and the expression in (18) is (strictly) larger than 1/2 otherwise. Since party 1 can either play τ_2^a or τ_2^b, it has to be the case that its expected equilibrium payoff weakly exceeds 1/2. And since exactly the same argument applies for party 2, it follows that indeed $U_i[\tau_i^k \mid s_i = k] = U_j[\tau_j^k \mid s_j = k] = \frac{1}{2}$ for $k \in \{a, b\}$ as claimed. ■

Proof of Lemma 3: Assume (5) does not hold, e.g. because $u(\alpha, \tau_a) < u(\alpha, \tau_b)$, yet τ_a and τ_b are set in a separating PBE. But then the deviation to play τ_b when the signal is a pays off when the other party plays τ_a by increasing the probability of winning from 1/2 to 1 and when the other other party plays τ_b by increasing the probability of winning from 0 to 1/2.■

Proof of Proposition 1: If both parties play τ independently of their signals, the voter is indifferent between the two parties and randomizes. On equilibrium, no information is transmitted and the voter's posterior equals her prior α. If e.g. party 1 deviates to some $\tau_1 \neq \tau$, then the voter must vote for 1 with a probability smaller than $\frac{1}{2}$. For this to be sequentially rational, her off equilibrium belief $\mu(\tau_1, \tau)$ must be such that her expected utility of voting for party 2 exceeds her utility of voting for the deviating party 1. Though PBE does not restrict the off equilibrium beliefs of the voter about the strategy played by the deviating party, it still imposes bounds on her beliefs $\mu(\tau_1, \tau)$: Given the observation (τ_1, τ) the belief most favorable for A is that the voter assumes party 1 plays the strategy "τ_1 if $s_1 = a$ and τ otherwise" while the least favorable belief is that 1 plays "τ_1 if $s_1 = b$ and τ otherwise". These assumptions imply, respectively, the updated beliefs $\mu(\tau_1, \tau) = \frac{\alpha(1-\varepsilon)}{\alpha(1-\varepsilon)+(1-\alpha)\varepsilon} = \mu(a, 0) < 1$ and $\mu(\tau_1, \tau) = \frac{\alpha\varepsilon}{\alpha\varepsilon+(1-\alpha)(1-\varepsilon)} = \mu(b, 0) > 0$. The voter's preferred policies, given these beliefs, are $\underline{\tau}(\alpha) \equiv \tau(\mu(a, 0)) < \overline{\tau}(\alpha) \equiv \tau(\mu(b, 0))$. Hence, for any "prescribed" equilibrium policy $\tau \in [\underline{\tau}(\alpha), \overline{\tau}(\alpha)]$ there are beliefs that make it rational not to vote for the deviating party: Just choose the off equilibrium beliefs $\mu(\tau_1, \tau)$ so that $\tau = \tau(\mu(\tau_1, \tau))$.

As for the separating PBE, notice first that one party choosing τ_a and the other one τ_b is an on equilibrium observation. Using Bayes' rule, the voter updates her beliefs to $\mu(\tau_a, \tau_b) = \frac{\alpha(1-\varepsilon)\varepsilon}{\alpha(1-\varepsilon)\varepsilon+(1-\alpha)(1-\varepsilon)\varepsilon} = \alpha$. Hence, the voter will be indifferent between the two. If both parties choose the same policy, he will also be indifferent between the two. In either case, she randomizes uniformly. If one party deviates and plays an off equilibrium policy τ, she must not vote for the deviating party with probability larger than one half. Upon observing (τ_1, τ_a) where τ_1 is the off equilibrium observation generated by party 1 and τ_a is the on equilibrium policy party 2 plays upon receiving $s_2 = a$ the voter's hypothesis that is most favorable for state A is that 1 plays the strategy "τ_1 if and only if $s_1 = a$". Consequently, $\max \mu(\tau_1, \tau_a) = \frac{\alpha(1-\varepsilon)^2}{\alpha(1-\varepsilon)^2+(1-\alpha)\varepsilon^2} = \mu(a, a)$. The least favorable hypothesis is "τ_1 if and only if $s_1 = b$", yielding $\min \mu(\tau_1, \tau_a) = \frac{\alpha\varepsilon(1-\varepsilon)}{\alpha\varepsilon(1-\varepsilon)+(1-\alpha)(1-\varepsilon)\varepsilon} = \alpha$. Similarly, upon observing (τ_1, τ_b) the most favorable hypothesis for state A is that 1 plays "τ_1 if and only if $s_1 = a$", yielding $\max \mu(\tau_1, \tau_b) = \frac{\alpha\varepsilon(1-\varepsilon)}{\alpha\varepsilon(1-\varepsilon)+(1-\alpha)(1-\varepsilon)\varepsilon} = \alpha$, and the least favorable hypothesis is "τ_1 if and only if $s_1 = b$", yielding $\min \mu(\tau_1, \tau_b) = \frac{\alpha\varepsilon^2}{\alpha\varepsilon^2+(1-\alpha)(1-\varepsilon)^2} = \mu(b, b)$.

Assume $\tau_a, \tau_b \in [\tau_a^*, \tau_b^*]$, where $u(\alpha, \tau_a) = u(\alpha, \tau_b)$. For any off equilibrium τ, i.e. for any $\tau \neq \tau_a, \tau_b$ there are beliefs that make it rational not to vote for the deviating party. Without loss of generality assume that the party that plays on equilibrium plays τ_b. If $\tau > \tau_b$, the voter can choose the belief α, so that $u(\alpha, \tau_b) > u(\alpha, \tau)$. For $\tau < \tau_b$, she can choose the belief $\mu(b, b)$ so that $u(\mu(b, b), \tau_b) > u(\mu(b, b), \tau)$. ■

Proof of Lemma 4: Suppose to the contrary that there is a separating PBE where, say, $\tau_a < \tau_a^*$, so that τ_a^* is an off equilibrium observation. Now upon observing one party playing τ_a and the other one the off equilibrium τ_a^*, the voter's belief that is worst for the party playing off equilibrium is $\mu(a, a)$ as may be recalled from the proof of Proposition 1. But with this belief the voter prefers τ_a^* to τ_a and so she will prefer the off equilibrium policy τ_a^* to τ_a for any belief $\mu \leq \mu(a, a)$ that is more favorable for the deviating party. An analogous argument applies for τ_b and τ_b^*. Finally, the deviation to τ_k^* upon signal k with $k \in \{a, b\}$ pays off for a party when both signals are strong: Since on-the-equilibrium path a party wins with probability 1/2 independently of its signal, the probability of winning upon receiving signal k and playing τ_k^* exceeds 1/2. Thus, the deviation is profitable. ■

Proof of Lemma 5: For $\alpha \in (\varepsilon, 1 - \varepsilon)$ both signals are strong. On equilibrium, i wins with probability 1/2 independently of its signal. Therefore, if there is a deviation that allows i to win with certainty against τ_k and to lose with certainty against τ_l with $k \neq l$, i wants to play this deviation upon signal $s_i = k$ and not upon signal $s_i = l$. From Lemma 4 it is known that $\tau_a^* \leq \tau_a$ and $\tau_b \leq \tau_b^*$. I will now argue that for $\tau_a^* < \tau_a$ and $\tau_b < \tau_b^*$ such a deviation exists, this deviation being τ_k^* upon signal k.

If only a party with signal a (type a for short) benefits from playing τ_a^*, the voter's belief upon observing (τ_a, τ_a^*) is $\mu(a, a)$, in which case she strictly prefers τ_a^* to τ_a by construction of τ_a^*. Hence the deviation pays off for type a if only type a benefits from it. To see that the latter is indeed true, notice that if both types benefit from playing τ_a^* the voter's belief upon observing (τ_b, τ_a^*) is $\mu(b, 0)$ because the deviating party's behavior is not informative. But recall now from Lemma 3 that $u(\alpha, \tau_a) = u(\alpha, \tau_b)$. Therefore, upon (τ_b, τ_a^*) and having belief $\mu(b, 0) < \alpha$, the voter strictly prefers τ_b to τ_a^* since $\tau_a^* < \tau_a$. Therefore, type b's payoff from the deviation τ_a^* is $(1 - \mu(b \mid b))$, which is strictly less than his equilibrium payoff of $1/2$ since b is a strong signal. Thus, it is not possible that both types benefit from the deviation τ_a^*. (And indeed, if only type a benefits, the voter's belief upon observing (τ_b, τ_a^*) is $\mu(a, b) = \alpha$, in which case she strictly prefers τ_b.) Completely analogous reasoning applies for $\tau_b < \tau_b^*$, Therefore, for $\tau_a > \tau_a^*$ ($\tau_b < \tau_b^*$) playing τ_a^* upon signal A (τ_b^* upon signal b) is a deviation that pays off. ■

Proof of Proposition 3: Consider a candidate separating equilibrium. Then upon a strong signal k it must be the case that parties play τ_k^*. Because for $\alpha \in (\varepsilon, 1 - \varepsilon)$ both signals are strong, separation in a PSE requires conditions (5) and (6) to hold. These impose two independent restrictions on τ_a and τ_b that in general will not hold simultaneously. So for $\alpha \in (\varepsilon, 1 - \varepsilon)$ there is generically no PSE where both parties separate. ■

Proof of Corollary 1: A pure strategy for a party can be either pooling, i.e. it sets the same policy independently of its signal, or separating, i.e. it sets different policies as a function of its signal. If the voter updates as required by Grossman and Perry (1986), the (or a) best response against a party who pools is $\tau(\alpha)$, and $\tau(\alpha)$ is the unique best response to itself, as shown in Proposition 2.

Since every PSE is an intuitive equilibrium, Proposition 3 implies that there are generically no separating PSE when both signals are strong. Moreover, since $\hat{\tau}_a$ and $\hat{\tau}_b$ are unique, there are no hybrid PSE where one party separates by playing $\hat{\tau}_k$ upon signal k and the other party pools by playing some τ independently of its signal since the voter will always strictly prefer $\hat{\tau}_k$ to $\tau \neq \hat{\tau}_a, \hat{\tau}_b$. It can also not be the case that one party pools at, say, $\tau = \tau_a^*$ and the other one separates because the separating party would have an incentive to play $\tau(\alpha)$, whereby it would win for sure. Thus, for $\alpha \in (\varepsilon, 1 - \varepsilon)$ the generically unique PSE outcome is $\tau(\alpha)$. ■

Proof of Proposition 4: Notice first that because $\varepsilon < 1/2$ either $\alpha > \varepsilon$ or $\alpha < 1 - \varepsilon$ holds. Therefore, there will be exactly one strong signal, a in the former, b in the latter case. Recall that upon receiving a strong (weak) signal a party has a posterior exceeding (less than) 1/2 that the other party has received the same signal. For the sake of the argument, suppose a is the strong signal, i.e. $\alpha > \varepsilon$, and assume $\tau_a \neq \hat{\tau}_a$. A necessary condition for (τ_a, τ_b) to be part of a separating equilibrium is that they satisfy $u(\tau_a, \alpha) = u(\tau_b, \alpha)$; see Lemma 3. I am now going to show that (τ_a, τ_b) with $u(\tau_a, \alpha) = u(\tau_b, \alpha)$ can be part of a separating PSE if and only if $\tau_a = \hat{\tau}_a$ holds. To see necessity, notice that party i can potentially benefit from a deviation both after $s_i = a$ and $s_i = b$ if upon the deviation it is elected with probability one if the other party plays τ_a. So upon seeing (τ_a, τ'), where τ' is a deviation by i, the voter's belief, updated according to PSE, is $\mu(a, 0)$. So unless $\tau_a = \hat{\tau}_a$, the voter prefers $\tau' = \hat{\tau}_a$ to τ_a. So on top of $u(\tau_a, \alpha) = u(\tau_b, \alpha)$ PSE requires $\tau_k = \hat{\tau}_k$, where $k \in \{a, b\}$ is the strong signal. Notice that there is now only one constraint, namely the one imposed by the strong signal, whereas in Lemma 5 there were two constraints that have to hold simultaneously on top of $u(\tau_a, \alpha) = u(\tau_b, \alpha)$. That such (τ_a, τ_b) exist is guaranteed by the symmetry assumption since $\hat{\tau}_a > \tau(1)$ and $\hat{\tau}_b < \tau(0)$.

To show sufficiency, maintain the assumption that signal a is strong. The last thing to show is that upon $s_i = b$ i has no incentive to deviate from τ_b, provided $\tau_a = \hat{\tau}_a$ and $u(\alpha, \hat{\tau}_a) = u(\alpha, \tau_b)$. By on equilibrium play i wins with probability 1/2 upon either signal. By construction of $\hat{\tau}_a$ there is no deviation that both types can beneficially play. Therefore, the only deviation that potentially benefits a party with signal b is one that the voter prefers if the other party plays τ_b. However, $\mu_i(s_j = b \mid s_i = b) < 1/2$ because b is the weak signal, so that the expected subjective payoff of the deviation is less than 1/2. Hence, there is no deviation that benefits only party b. Thus, no profitable deviation exists.

Since every PSE is intuitive, it follows that there are intuitive separating equilibria when one signal is weak.

■

Proof of Proposition 5: To see that $\tau \notin [\tau(\mu(a, a)), \tau(\mu(a, a))]$ is not the outcome of a pooling equilibrium, it suffices to notice that party 2 could play $\tau(\mu(a, a))$ (or $\tau(\mu(b, b))$) after party 1 played the prescribed equilibrium policy $\tau < \tau(\mu(a, a))$ (or $\tau > \tau(\mu(b, b))$). Since there are no beliefs that make it sequentially rational to prefer $\tau < \tau(\mu(a,a))$ over $\tau(\mu(a,a))$ (or to prefer $\tau > \tau(\mu(b,b))$ over $\tau(\mu(b,b))$) it follows that such a τ is not an equilibrium policy.

To see that any $\tau \in [\tau(\mu(a,a)), \tau(\mu(a,a))]$ is the outcome of a pooling equilibrium satisfying CK, recall first that on equilibrium each party is elected with probability 1/2. Thus, no deviation is equilibrium payoff dominated. Thus, CK does not pin down off equilibrium beliefs. Second, assume that the equilibrium strategies are such that party 2 plays τ no matter what party 1 played. Since there are beliefs that make it sequentially rational to prefer $\tau \in [\tau(\mu(a,a)), \tau(\mu(b,b))]$ to any other policy, it follows that τ is a pooling equilibrium outcome that satisfies CK.

Last, consider the PSE equilibrium outcome $\tau(\alpha)$. Given that party 1 pools at $\tau(\alpha)$ any deviation by the other one from the prescribed policy $\tau(\alpha)$ would be pooling and would hence be defeated. Party 1 on the other hand has no incentive to deviate either because party 2 can simply play $\tau(\alpha)$ and guarantee that it wins, given that 1's deviation would be pooling. Uniqueness follows along the previous lines: Any deviation by 2 would be pooling. So 2 could profitably deviate if the prescribed policy were not $\tau(\alpha)$. ■

Proof of Proposition 6: Let 1 play τ_k, $\tau_k = \hat{\tau}_k \equiv \arg\max_\tau u(\mu(k,0),\tau)$ upon signal $s_1 = k$ with $k = a, b$. If his signal is k as well, 2 plays $\hat{\tau}_k$ as well. So upon observing 1 and 2 play $\hat{\tau}_k$ the voter holds the belief $\mu(k,k)$ and randomizes uniformly between the two policies. If his signal is not k, 2 plays τ'_k defined as the $\tau \neq \hat{\tau}_k$ that solves $u(\alpha, \hat{\tau}_k) = u(\alpha, \tau)$. Upon observing $(\hat{\tau}_k, \tau'_k)$ the voter's belief is α and she is, again, indifferent between the two proposals.

Now 2 has no incentives to deviate as any of his deviations would be pooling (as both of his types can potentially benefit from the deviation) and thus induce the voter to have the belief $\mu(k,0)$, so that the voter strictly prefers 1's proposal. Similarly, but slightly more complicatedly, 1 has no incentive to deviate either as his deviations would be pooling as well. The best response of 2 would thus be to play $\tau(\alpha)$ independent of his signal and get elected with probability of, at least, 1/2 (exactly 1/2 if 1 deviated to $\tau(\alpha)$ and 1 otherwise). ■

Proof of Proposition 7: If both parties pool, the voter's posterior equals the prior both on and off equilibrium. So off and on equilibrium there's no policy she'd prefer to $\tau(\alpha)$. ■

Sketch of Proof of Proposition 8: The fact that τ^O exists is irrelevant in the sense that for any admissible belief $\mu \in [\mu(a,a), \mu(b,b)]$ τ_a^* or τ_b^* (or both) will be preferred to τ^O. ■

Sketch of Proof of Lemma 6: Suppose party i of quality O can successfully signal its quality (and benefit from doing so). Then if its quality were C it would benefit from behaving as if it were of $q = O$, and vice versa. ■

B Separating D1 Equilibrium

Proposition 10 *If one signal is weak, there is a unique separating equilibrium outcome satisfying D1.*

Proof of Proposition 10: Recall that (i) $\mu(a|a) > 1 - \mu(b|b)$ and assume that (ii) $\mu(a|a) > 1/2 > \mu(b|b)$. The latter is wlog insofar as D1 can only have additional bite compared to CK when one signal is weak, and letting b be the weak signal is definitely wlog. (If both signals are strong, then there are no separating equilibria satisfying CK and consequently there are a fortiori none that satisfy D1).

Let $\theta \in \{\theta_a, \theta_b\}$ be the types of the receiver, where θ_k is the type that occurs whenever the other (non-deviating) sender plays the strategy he is supposed to play upon signal k. Denote by $\sigma \in \{\sigma_a, \sigma_b\}$ the deviating sender's types. I first show that rather trivially the set inclusion of mixed strategies does not eliminate any type if the receiver plays an unconditional mixed strategy, that is if she elects the deviator with probability $v \in (0,1)$ independently of her own type. This is trivially true because the $v(\sigma)$ that makes type σ indifferent between deviating and not is $v(\sigma_a) = v(\sigma_b) = 1/2$ for the simple reason that in equilibrium both are elected with probability 1/2.

Upon a given deviation τ let (x, y) be the strategy of the receiver, where x is the probability she votes for the deviator if her type is θ_a and y the corresponding probability when her type is θ_b.

In a separating equilibrium there is a unique deviation policy $\tilde{\tau} \in (\tau_a, \tau_b)$ such that the receiver is indifferent between τ_a and $\tilde{\tau}$ when of type θ_a and between $\tilde{\tau}$ and τ_a when of type θ_b, keeping her beliefs about the deviator's type fixed. More formally, let $\sigma_{\theta_k}(\tau)$ be the probability that the sender is of type σ_a when making the deviation τ such that the receiver is indifferent between τ_k and τ when of type θ_k, i.e. $u(\mu_{\theta_k}, \tau_k) = u(\mu_{\theta_k}, \tau)$. Notice that for $\tau \in (\tau_a, \tau_b)$, $\sigma_{\theta_a}(\tau)$ is monotonically and continuously decreasing and satisfies $\lim_{\tau \to \tau_a} = 1$ and $\lim_{\tau \to \tau_b} = 0$.

Analogously, $\sigma_{\theta_b}(\tau)$ is a monotonically and continuously increasing function of τ for $\tau \in (\tau_a, \tau_b)$ and satisfies $\lim_{\tau \to \tau_a} = 0$ and $\lim_{\tau \to \tau_b} = 1$. Consequently, there exists exactly one $\tilde{\tau}$ such that $\sigma_{\theta_a}(\tilde{\tau}) = \sigma_{\theta_b}(\tilde{\tau})$. The sender of type σ_a will be indifferent between the deviation $\tilde{\tau}$ and equilibrium play if $v_{\theta_a}\mu(a|a) + v_{\theta_b}(1 - \mu(a|a)) = 1/2$. The largest mixture in v_{θ_a} (and smallest in v_{θ_b}) that keeps him indifferent is $\left(\frac{1}{2\mu(a|a)}, 0\right)$ and the smallest mixture in v_{θ_a} (and largest in v_{θ_b}) that keeps him indifferent is $\left(\frac{2\mu(a|a)-1}{2\mu(a|a)}, 1\right)$. Analogously, for type σ_b the indifference condition is $v_{\theta_a}(1-\mu(b|b)) + v_{\theta_b}\mu(b|b) = 1/2$, so that the largest and smallest mixtures that keep type σ_b indifferent are, respectively, $\left(\frac{1}{2(1-\mu(b|b))}, 0\right)$ and $\left(\frac{1-2\mu(b|b)}{2(1-\mu(b|b))}, 1\right)$. It is straightforward to establish that $\frac{1}{2\mu(a|a)} < \frac{1}{2(1-\mu(b|b))}$ and $\frac{1-2\mu(b|b)}{2(1-\mu(b|b))} < \frac{2\mu(a|a)-1}{2\mu(a|a)}$ so that neither set includes the other one. Consequently, no type $\sigma \in \{\sigma_a, \sigma_b\}$ can be deleted upon the deviation $\tilde{\tau}$, and the receiver is free to chose her beliefs in this instance.

So consider now any other deviation $\tau \in (\tau_a, \tau_b) \setminus \tilde{\tau}$. These deviations are such that the receiver can randomize for at most one of her types. That leaves us with the following four cases: 1. $(1, v_{\theta_b})$, 2. $(0, v_{\theta_b})$, 3. $(v_{\theta_a}, 1)$ and 4. $(v_{\theta_a}, 0)$, where $v_{\theta_k} \in [0, 1]$ is the probability she chooses the deviator if her type is θ_k. Since both sender types (σ_a, σ_b) will benefit from a deviation if the receiver plays $(1, 0)$, case 1 does not eliminate any sender type. Notice also that for a given deviation τ there are (different) beliefs about the deviating sender's types μ_{θ_a} and μ_{θ_b} that make it sequentially rational to play $(v_{\theta_a}, 0)$ or $(0, v_{\theta_b})$, respectively, if and only if the deviation τ satisfies $\tau_a < \tau < \tau_b$. The reason is simply that the receiver's indifference between τ_a and τ_b given the prior α makes it impossible for her to be indifferent between, say, τ_a and $\tau > \tau_b$ because α will be the most favorable belief she can have for τ when the non-deviating sender plays τ_a (i.e. when she is of type θ_a).

Consider first the strategy $(v_{\theta_a}, 0)$.[32] Let $v_{\theta_a}(\sigma)$ be the probability that makes type σ indifferent. We have

$$\begin{aligned} v_{\theta_a}(\sigma_a)\mu(a|a) &= 1/2 \Leftrightarrow v_{\theta_a}(\sigma_a) = \frac{1}{2\mu(a|a)} && (19) \\ v_{\theta_a}(\sigma_b)(1 - \mu(b|b)) &= 1/2 \Leftrightarrow v_{\theta_a}(\sigma_b) = \frac{1}{2(1 - \mu(b|b))}. && (20) \end{aligned}$$

Observe that $v_{\theta_a}(\sigma_b) > v_{\theta_a}(\sigma_a)$. So the set of mixed strategies that makes type σ_b better off than in equilibrium is a strict subset of the corresponding strategies for type σ_b.

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[32] Observe that, as shown in the paper, both types σ will benefit strictly if the receiver plays $v_{\theta_a} = 1$ independently of v_{θ_b} because signal a is strong.

Consider now the strategy the strategy $(0, v_{\theta_b})$. We have:

$$\begin{aligned} v_{\theta_b}(\sigma_a)(1-\mu(a|a)) &= 1/2 \Leftrightarrow v_{\theta_b}(\sigma_a) = \frac{1}{2(1-\mu(a|a)})) \quad (21)\\ v_{\theta_b}(\sigma_b)\mu(b|b) &= 1/2 \Leftrightarrow v_{\theta_b}(\sigma_b) = \frac{1}{2\mu(b|b)}. \quad (22)\end{aligned}$$

Fact (i) is equivalent to $\mu(b|b) > 1 - \mu(a|a)$. Consequently, $v_{\theta_b}(\sigma_b) < v_{\theta_b}(\sigma_a)$. So the set of mixed strategies that makes type σ_a better off than in equilibrium is a strict subset of the corresponding strategies for type σ_b. (Similar computations can be done for $(v_{\theta_a}, 1)$ but adding these won't exclude any additional type since the set of types who can benefit 'most' is already maximal.) Consequently, for deviations $\tau \in (\tau_a, \tau_b)$ D1 has no bite in that it does not eliminate any types. Consequently, for such deviations the receiver is free to choose her beliefs, and thus such deviations can be deterred without further ado.

Next consider a deviation $\tau < \tau_a$ and assume $\tau_a > \tau_a^* \equiv \tau(\mu(a,a))$. This is for example the case if $\tau_a = \hat{\tau}_a \equiv \tau(\mu(a,0))$ as in the separating PSE. (The logic is quite similar for deviations $\tau > \tau_b$ but somewhat less important, b being the weak signal.) The fact that $\tau_a > \tau_a^*$ implies that there is a policy $\tau' < \tau_a^*$ such that $u(\mu(a,a),\tau') = u(\mu(a,a),\tau_a)$. By continuity for any $\tau'' \in (\tau', \tau_a^*)$ there exist beliefs that put positive probability on each of the deviating sender's types (σ_a, σ_b) μ_{θ_a} that make the receiver of type θ_a indifferent and hence voting for the deviator with probability v_{θ_a} sequentially rational. Because $\mu(a|a) > 1 - \mu(b|b)$ such deviations are infinitely more likely to arise from a type σ_a than from a type σ_b (see the derivations above). Consequently, the unique best reply by the receiver will be $v_{\theta_a} = 1$ given τ'' and consequently a necessary condition for τ_a to be a D1 equilibrium policy is $\tau_a \leq \tau_a^*$. (For otherwise the deviation to τ_a^* pays off for the type σ_a.) Analogously, upon $\tau > \tau_b$ where $\tau_b < \tau_b^*$ the optimal sequentially rational choice for the type θ_b receiver is to elect the deviator with probability 1, i.e. $v_{\theta_b} = 1$. But since $\mu(b|b) < 1/2$ such a deviation does not pay off.

Last notice that $\tau_a = \tau_a^*$ and $\tau_b \neq \tau_a^*$ such that $u(\alpha, \tau_a^*) = u(\alpha, \tau_b)$ is also sufficient for these be equilibrium policies in a D1 equilibrium: Deviations inside (τ_a^*, τ_b) can be deterred as argued above. Deviations below τ_a^* are interpreted as stemming from type σ_a only, so that the receiver prefers τ_a^* to the deviation (and a fortiori she prefers τ_b to the deviation) while deviations to $\tau > \tau_b$ are interpreted as stemming from type σ_b only, so that no special deterrence is required for these because being chosen with probability 1 if the opponent has received the weak signal and with probability 0 otherwise is not a profitable deviation.

Summarizing, we have a separating D1 equilibrium if and only if $\tau_a = \tau_a^*$ and $\tau_b \neq \tau_a$ is such that $u(\alpha, \tau_a^*) = u(\alpha, \tau_b)$. (The only if part follows from the insight that no $\tau < \tau_a^*$ can be supported as an equilibrium policy if signal a is strong.)

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