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Competing influence

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Abstract

This paper investigates the incentives of experts competing to influence decision making. Competition for influence is shown to have an ambiguous effect on truthtelling incentives and a decision maker might be better off relying on one source of information only. This result has important implications for organizational design: the paper shows that delegation and favoritism can arise as a way to promote the correct flow of information within an organization. Delegation can lead to stronger truthtelling incentives than communication and it can be optimal when the importance of the decision is intermediate or high. Favoritism, consisting in biasing the competition for influence in favour of one expert, can further increase truthtelling incentives.

JEL Classification: C73, D82, L23.
Keywords: reputation, competition, delegation, favoritism.

Contents

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1 Introduction[1]

This work aims at a better understanding of delegation and favoritism in organizations by analyzing of the incentives created by competition to influence decision-making. This paper argues that the choice between delegating decision powers as opposed to relying on communication of information from multiple experts is crucially shaped by the incentives created by competition for influence. Results are based on the analysis of the effects of competition in a dynamic game of information transmission where senders (experts) who have a conflict of interest with the decision maker are motivated by reputational concerns to report information truthfully. The novel theoretical feature of this paper is that it introduces multiple senders in this framework and identifies conflicting forces generated by competition among senders. Firstly, competition for influence induces a reduced influence effect: biased senders have fewer chances to influence decision-making both in the current period and in the future. Reduced future influence decreases biased senders' incentives to maintain an untarnished reputation as the presence of competitors makes it less likely that a sender who behaves in the present will be able to cash in the benefits of her undamaged reputation. Lower current influence reduces a biased sender's opportunity to mislead the decision maker in the current period and increases her incentives to report information truthfully. Competition also generates a lost reputation effect which can raise truthtelling incentives: a sender fears other senders gaining more influence as her own reputation falters when other senders have preferences that do not match with his own. Finally, competition allows the decision maker to aggregate more information and this may enable, in some circumstances, the decision maker to distinguish correct reports from wrong reports. The balance between these effects is ambiguous and facing multiple senders is not always beneficial for the receiver. This result has important implications for organizational design. Organizations can decide to let agents compete to influence decision-making, thus aggregating all the available information. When the reduced future influence effect is very strong, however, organizations might find it optimal to commit to delegate decision powers to only one sender. The model shows that experts might be delegated decision powers on certain tasks in order to limit competition for influence and spur truthtelling incentives. The model also shows that it can be optimal to commit to bias the competition for influence as favouring one of the experts helps create additional incentives to report information truthfully. Although favoritism characterizes the everyday life of many organizations, it has received little attention in formal economic analysis and this work shows it could arise as a rational organizational response to the problem of fostering truthtelling incentives. Finally, the model shows that different organizational forms are preferred as a function of the importance of the decision at

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stake.

Results can be applied to describe many real world situations in which a decision maker relies on the information provided by experts who may have a vested interest in inducing certain decisions. A major application is the analysis of resource allocation within a firm: the chief financial officer, CFO (the decision maker), is allocating funds among projects in a firm and wants to elicit information about them from project leaders (experts) in order to allocate funds to the most promising project. However, project leaders may derive a private benefit if more funds are allocated to a specific project. This paper shows how the incentives of project leaders to report the truth change if the CFO collects information from all competing projects leaders and centralizes the decision as opposed to delegating decisions to one project leader. The results of the paper can be applied to describe other economic interactions of interest such as politicians competing to be elected, lobbies attempting to influence politicians, financial analysts providing information to investors and investment banks advising corporate clients.

1.1 Related literature

This paper is based on the literature investigating the transmission of information from possibly biased experts, in particular the contributions of Sobel (1985) and of Benabou and Laroque (1992). They derive conditions ensuring that reputational incentives are effective in inducing biased experts to report their information truthfully. The main difference is that this paper introduces a second informed sender (and analyzes the extension to n senders), so that truthtelling incentives are created both by the desire to keep a reputation and by the competition for influence. Moreover, it differs in the way the bias of senders is modelled: in both Sobel and Benabou and Laroque a biased sender always has a conflict of interest with the decision maker, while in this model senders always prefer a given decision which might coincide with the preferences of the decision maker depending on the realization of the state of the world. This can be a more interesting way to model the preferences of experts in many applications.

Horner (2002) is also relevant as he shows how reputation and competition interact to create incentives for the producers of a good. Competition has the role of enforcing the production of high quality goods because it creates an outside option for consumers as they will switch to a different producer upon receiving a low quality good. A critical difference is that Horner deals with an environment where monetary transfers are not allowed. More importantly, he does not discuss the implications of the interactions of reputational incentives and competition on organizational design.

The rationale for delegating authority is investigated by a broad and varied economic literature, with Aghion and Tirole (1997) being among the most important contributions. However, few papers deal with settings without transfers. Dessein (2002) is the first to discuss delegation in a cheap talk setting. He evaluates the use of delegation as opposed to communication in a model à la Crawford and Sobel (1982), where the sender's bias is public knowledge. Delegation is shown to improve upon communication as the latter involves a garbling of information due to the sender's bias. This work differs as it deals with a setting where multiple senders transmit information and their bias is unknown. Results are also different. Communication (letting senders compete for influence) can be preferable to delegation, depending on the importance of the decision.[2] Moreover, a combination of communication and delegation can improve upon both pure communication and pure delegation. This seems to be a broader view of organizational life, as delegation and communication coexists in practice and the choice between the two is often dictated by the importance of the decision at hand.

This paper is also related to some contributions investigating the optimal design of delegation as a way to promote information transmission, Alonso and Matouschek (2007 - I and 2007 - II) and Aghion, Dewatripont and Rey (2004). The latter is especially relevant as they investigate the effect of transferring control in situations where an expert is motivated by reputational concerns. Melumad and Shibano (1991) and Szalay (2005) also provide related results. They investigate whether the decision maker can improve information transmission by committing to follow certain decision rules. All these papers, however, do not deal with competition and rather focus on the role of the alignment of incentives between the sender and the decision maker.

This paper also explores the literature on favoritism. Only a few papers in economics deal with this issue. The first is Prendergast and Topel (1996) who show that allowing managers to reward their favorite employees might be a cheap way of providing incentives. However the authors assume that managers utility is increasing if their subordinates get promoted. This assumption is key to generate a role for favoritism. Another is Kwon (2006) who generates endogenously a preference for favoritism in a model where inventors compete to have their project implemented and the decision maker designs an optimal incentive scheme. However, he deals with a model where inventors become informed after exerting costly effort and the effects generated by competition are rather different.[3]

This work is related to the literature on influence activities. Milgrom and Roberts (1988) represents an early important contribution in the area. They show that employees might want to allocate effort to produce information about their ability. Such information is valuable for the firm, but comes at the cost of subtracting effort away from other productive activities. Milgrom and Roberts discuss organizational responses to the presence of excessive influence activities. My model shares the view that organizational form is an instrument that can be employed to improve the transmission of relevant information. However, influence activities are modelled rather differently and this literature has paid little attention to the explicit analysis of the effects of competition in

[2] And independently of the bias of the experts which is unknown.

[3] In Kwon (2006) the assumptions about effort costs are key in delivering the result that symmetric effort (induced by "fairness") improves upon favoritism.

inducing the correct transmission of information.[4]

Finally, this work draws on the literature on cheap talk games. Following the seminal contribution of Crawford and Sobel (1982), a large literature developed focussing on different variations on the theme, taking both a purely theoretical and an applied perspective. Among these contributions, Gilligan and Krehbiel (1989) and Krishna and Morgan (2001) are the closest as they investigate the effect of the presence of two senders. However, they do not investigate situations where the bias of senders is not perfectly known and agents are motivated by reputational concerns.

The paper is structured as follows: section 2 describes the model, section 3 derives the equilibrium when the decision maker cannot commit to delegate decision powers and compares the one and the two senders case, section 4 discusses the role of delegating authority to one of the senders and why favoritism can be optimal, section 5 analyses the welfare of the decision maker, section 6 shows when it can be optimal to delegate decision powers to an agent with a less established reputation, section 7 extends the model to the case of n senders competing to influence the decision maker, section 8 contains a discussion of the assumptions, the modelling strategy, and applications, section 9 concludes.

2 The model

The strategic interaction between the decision maker (DM, she) and senders (he) is modelled as a two period game. The same stage game is repeated in each period.

Information structure: At the beginning of the first period nature draws the types of senders. They might be honest (unbiased), left-biased or right-biased. A sender's type is his private information, is constant over time, and is distributed according to the probability distribution $\Pr(i = Honest) = p^i$, $\Pr(i = \text{left-biased}) = \Pr(i = \text{right-biased}) = \frac{1-p^i}{2}$. Firstly, both senders will be assumed to have the same ex-ante chance of being honest. In such a case, $\Pr(i = H) = \Pr(-i = H) = p$.

Every period, nature draws a random variable $y \in \{L, C, R\}$ representing the state of the world. State realizations across periods are independent. States L and R are equally likely and occur with probability $\alpha < \frac{1}{2}$, state C, has prior probability $1-2\alpha$.[5] The parameter α can represent the inverse of the degree of conflict of interest with the decision maker. In fact, the smaller α, the less likely the state preferred by biased senders, thus the stronger the conflict of interest. States of the world in different periods are drawn independently. Senders privately observe a

[4] Rotemberg and Saloner (1995) is also broadly related as the authors show that conflict between members of an organization can foster information production. The bad side of conflict is that producing information is costly, and too much conflict can lead to excessive effort being devoted to information production.

[5] This also includes the case in which all states of the world are equally likely ($\alpha = \frac{1}{3}$).

signal that perfectly reveals the realization of the state of the world. Moreover, nature draws a random variable that defines period importance. This is represented by the random variable A with support $\Gamma = [\underline{A}, \overline{A}], \underline{A} > 0$, and distributed according to a continuous distribution function $G(\cdot)$ for the decision maker, and by the random variable B, with support $\Phi = [\underline{B}, \overline{B}]$, $\underline{B} > 0$ and distributed according to the continuous distribution function $H(\cdot)$, for senders. The distribution H is atomless. The realization of period importance is common knowledge and observed before messages are sent and decisions made. Finally, decision maker's payoff is commonly observed, while each sender's payoff is his private information.[6]

Players and actions: The decision maker interacts with one or two senders. In each period the decision maker implements a decision $d \in \{L, C, R\}$. Senders provide a message $m \in \{L, C, R\}$, suggesting the appropriate course of action. After observing the messages, the decision maker decides what action to implement.

Player's payoffs: The decision maker wishes to implement the decision that matches the state of the world. Formally, $U^{DM} = A$ if $d = y$ and $U^{DM} = -A$ if $d \neq y$[7]. Honest senders have the same preferences over actions as the decision maker, so that $U^H = B$ if $d = y$, and $U^H = -B$ otherwise. On the contrary, left-biased senders always prefer decision L to be implemented, so that $U^L = B$ if $d = L$ and $U^L = -B$ if $d \neq L$. Analogously right-biased senders always prefer decision R to be implemented, so that $U^R = B$ if $d = R$ and $U^R = -B$ if $d \neq R$. Notice that this implies biased types suffer the same "damage" if their preferred decision is not implemented, independently of the "distance" of the decision from their preference. In fact, a left-biased sender incurs a loss of $-B$ both if decision C is made and if decision R is made[8]. I am also assuming the decision maker cannot adjust the intensity of the action as a function of the reputation of each sender nor as a function of the magnitude of the "consensus": the decision maker might want to trust more the information provided by senders if they report the same information, and less if they don't. This possibility is explored further in the paper when I extend the model to allow for the presence of more than two senders. Finally, I am assuming there is no type biased towards state C. This is both interesting in itself, as it allows to explore the effect of having a decision that is "unbiased"[9], and useful to keep the model tractable.

Contracts: this model aims at describing an environment where it is difficult to write complete contracts to govern agents' interactions. Senders' private signals are not verifiable to court, and money cannot be transferred among players. The main contractible variable is the power to influence decision-making. In the first part of the paper, it will be assumed that the decision

[6] This assumption is needed to avoid perfect revelation of a sender's type when payoffs are realized. However, decision maker's payoffs could be assumed to be unobservable without altering any of the results.

[7] The subscripts DM, H, L, R denote, respectively, the payoff functions of Decision Maker, Honest, Left biased and Right biased.

[8] It could be the case that left biased senders prefer decision C over decision R and right biased senders prefer decision C over decision L. Allowing for this possibility adds little to the economic intuition.

[9] I mean a decision which is not preferred by any biased type.

maker is not able to credibly commit to delegate decision powers to a sender. This assumption will be removed in the section on delegation and favoritism.

Timing: there are two periods. At the beginning of the first period, senders' types are drawn and privately observed by each sender only.[10] Then the state variable is drawn and privately observed by senders only. The period importance realization for decision maker and senders is drawn and commonly observed.[11] Senders simultaneously report messages, the decision maker chooses a course of action, possibly on the basis of senders reports, payoffs are realized, and the decision maker updates her beliefs about senders' type. The same stage game is repeated in the second period, with the exception that senders' types are still the same as in the first period.

Strategies and beliefs: for ease of exposition it is assumed that honest senders are committed types and always report information truthfully.[12] Therefore, attention should be placed on biased senders. left-biased sender i reports the state realization truthfully in period t with probability $q^s_{i,t}(h_t)$, where s represents the true realization of the state of the world and h_t is the history of the game at the beginning of date t. Analogously, right-biased senders report information truthfully with probability $z^s_{i,t}(h_t)$. The dependence on the state of the world follows because the true state can coincide with the preferred decision for the sender, and this affects the willingness to report the state truthfully. The decision maker updates her beliefs about sender i type through Bayes rule. At the beginning of the first period, $p_1 = p$ while at the beginning of the second period

$$p_{i,2} = \frac{p}{p + \frac{1-p}{2} q^s_{i,1} + \frac{1-p}{2} z^s_{i,1}} \quad \text{if } m = y \text{ (report was truthful)}$$

$$p_{i,2} = 0 \quad \text{if } m \neq y \text{ (report was false)}$$

Strategies for the decision maker are mappings from the set $\{m_1, m_2\} \times \{i, -i\}$ to the set of actions. In words, the decision maker chooses decision d, when sender i reported message m_i, and sender $-i$ reported message m_{-i} in period t, with probability $\nu^{d,i,m_i,m_{-i}}(h_t) \in [0, 1]$, where again h_t is the history of the game at the beginning of date t. Such probabilities depend upon the credibility of the sender's report and upon the messages sent.

3 Communication

In this section it is assumed that the decision maker cannot commit to grant decision powers to a given sender. Senders communicate their information to the decision maker who chooses the

[10] Sender i knows his type, but not sender $-i$'s type.

[11] There is no loss of generality in assuming that the decision maker observes her own period importance realization and senders observe theirs. However, to decide whether delegation or favouritism are better than communication, the decision maker should be able to get at least an informative signal about the realization of period importance for the senders. This point will be discussed further later on.

[12] This is with little loss of generality. Without that assumption, there could exist babbling equilibria in which the decision maker discards all information transmitted and senders randomize among messages. It is important to stress that all the equilibria derived under the assumption that honest senders always report the truth are still equilibria when that assumption is removed.

appropriate course of action.

The equilibrium concept is Perfect Bayesian Equilibrium. I limit attention to strategies based upon current history. An equilibrium is a set of strategies $q^s_{i,t}(h_t)$, $z^s_{i,t}(h_t)$ for left and right-biased senders and $\nu^{d,i,m_i,m_{-i}}(h_t)$ for the decision maker, as defined above, and a set of beliefs $\{p, p_{i,2}\}$ for the decision maker, so that strategies are sequentially rational for a given set of beliefs and beliefs are consistent given the strategy profile. For ease of notation I will drop the dependence of q, z and ν on h_t and that of p_2 on i.

The analysis is centered on truthtelling equilibria, i.e. equilibria in which biased senders report information when they have incentives to do so, and the decision maker finds it optimal to use the information provided by senders.[13] The goal is to identify conditions such that truthtelling equilibria exist. Information transmission can take place as long as the probability senders are honest ("sender's credibility") is large enough. When the credibility of a sender is too low, the decision maker discards the messages received and biased senders randomize.

In order to simplify the analysis, I assume that $\alpha > \frac{1}{3}$ (but $\alpha < \frac{1}{2}$). This ensures the decision maker prefers to randomize between actions L and R when uninformed.[14]

It is useful to state four preliminary results, common to the one and two senders games.

Lemma 1 *In a truthtelling equilibrium: 1. A biased sender always suggests his preferred decision to be implemented in the last period if he has enough credibility to transmit information. 2. A biased sender always reports the truth when the state of the world coincides with his preferences and he has enough credibility to transmit information. 3. The decision maker prefers to randomize between action L and R when uninformed. 4. The decision maker is willing to implement the decision proposed by the sender with positive probability in period* 2 *if and only if* $p_2 > \frac{1-2\alpha}{2(1-\alpha)}$.

Proof. See the appendix. ■

Notice that, as the degree of conflict of interest is reduced, i.e. α is larger, prior reputation necessary for information transmission to occur, gets smaller.

Firstly, I will analyze the game where one sender tries to influence the decision maker, then I will turn to the two senders game. I describe the behavior of a left-biased sender, as that of a right-biased sender is analogous.

One sender. In order to analyze an interesting problem, I assume throughout that the prior probability the sender is unbiased is larger than $\frac{1-2\alpha}{2(1-\alpha)}$. This is a necessary condition for the

[13] There can also exists "partial babbling equilibria" in which the decision maker only listens to one sender and discards the messages of the other who randomizes among messages. Such situation would be similar to that analyzed when discussing delegation.

[14] Without this assumption results are qualitatively unchanged, and some of them even stronger, as will be underlined in due course. An interpretation of this assumption, in the example of resources allocation within a firm, is that state C corresponds to "discard all projects". (this does not provide private benefits to any biased project leader). However, ex ante, it is more likely that undertaking either project L or project R is more likely than "discard all projects".

existence of a truthtelling equilibrium in pure strategies. In the second period a left-biased sender always reports that the true state is L, which implies $q_2^L = 1$ if the state is L and $q_2^C = q_2^R = 0$, otherwise. In the first period a left-biased sender trades off current gains with the possibility of influencing the decision in the future. If the true state is L, the sender reports the truth for sure, as this involves no reputational loss. If instead the true state is either zero or R, the payoff of a left-biased sender by reporting the truth in period 1 is

$$V_T = -B + \delta E(B)$$

where $\delta \in (0;1]$ is a discount factor and $E(\cdot)$ denotes the expectation operator, so that $E(B) = \int_\Phi BdH(B)$. The payoff from lying is given by

$$V_L = B$$

This follows because if a sender lies in the first period, his second period reputation is destroyed as the posterior probability he is honest is $p_2 = 0$. Therefore the decision maker will not listen to the sender in the second period, and will make an uninformed decision which yields an expected payoff of zero. As the sender is not believed because his reputation is gone, a biased sender without reputation randomizes among messages. Under the assumption that $p > \frac{1-2\alpha}{2(1-\alpha)}$, it is possible to prove the following

Proposition 1 *In the one sender case, a biased sender reports information truthfully in pure strategies in the first period if: 1. The true state coincides with her preferences. 2. The true state does not coincide with her preferences, but the decision at stake is not too important, in particular:* $B < \dfrac{\delta E(B)}{2}$. *When the true state does not coincide with her preference, a biased sender can report information truthfully in mixed strategies, in the first period, but this is a zero probability event.*

Proof. See the appendix. ■

The intuition for this result is standard and is analogous to that in Sobel (1985): if the realization of decision importance in the first period is not too high, a biased sender is willing to incur a current loss in order to be able to influence the decision maker in the second period.

I now move to the analysis of the game where two senders report information and show the effects of competition on truthtelling incentives.

Two senders. It is useful to state two preliminary results.

Lemma 2 *In a truthtelling equilibrium: 1. The decision maker always uses the information provided by senders if they have enough credibility. 2. There is always truthtelling in the first period if the true state is* C.

Proof. See the appendix. ■

The first part says that the decision maker never benefits from discarding information when senders have enough credibility to ensure information transmission takes place. Formally, this implies that, when senders have enough credibility, the chosen decision d coincides either with m_i, or with m_{-i}. Thus, I drop the dependence of ν on d, and the lemma also implies that $\nu^{i,m_i,m_{-i}} + \nu^{-i,m_i,m_{-i}} = 1$. The second part follows because C is the "unbiased" action. In a truthtelling equilibrium, the opponent reports the truth. When the true state is C, the decision maker observes a message suggesting state C from the opponent. Then, there is no profitable deviation because the decision maker knows that C is not the preferred action of any biased type and it must be the true state.

The effects of competition on truthtelling incentives can be illustrated by examining the behavior of a biased sender when the observed state does not coincide with his preferences and there is a conflict of interest with the decision maker. I assume the sender is left-biased and the true state is R.[15] Biased senders always lie in the last period.[16] The payoff of a left-biased sender i, in such a case, is given by

$$\begin{aligned} V_T^i =& [p + \frac{(1-p)}{2} + \frac{(1-p)}{2} q_{-i}^R](-\nu_1^{i,R,R} - \nu_1^{-i,R,R})B + \frac{1-p}{2}(1-q_{-i}^R)(-\nu_1^{i,R,L} + \nu_1^{-i,R,L})B + \\ & \delta E(B)[\frac{(1-p)}{2} q_{-i}^R(\nu_2^{i,L,L} + \nu_2^{-i,L,L}) + p(\alpha(\nu_2^{i,L,L} + \nu_2^{-i,L,L}) - (1-2\alpha) + \alpha(\nu_2^{i,L,R} - \nu_2^{-i,L,R})) + \\ & \frac{(1-p)}{2}(\nu_2^{i,L,R} - \nu_2^{-i,L,R}) + \frac{(1-p)}{2}(1-q_{-i}^R)] \end{aligned} \quad (1)$$

if he reports truthfully in the first period, and

$$\begin{aligned} V_L^i =& [p + \frac{(1-p)}{2} + \frac{(1-p)}{2} q_{-i}^R](\nu_1^{i,L,R} - \nu_1^{-i,L,R})B + \frac{1-p}{2}(1-q_{-i}^R)(\nu_1^{i,L,L} + \nu_1^{-i,L,L})B \\ & + \delta E(B)[\frac{(1-p)}{2} q_{-i}^R - \frac{(1-p)}{2} + p(\alpha - (1-2\alpha) - \alpha)] \end{aligned} \quad (2)$$

if he lies.[17]

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[15] The case of a right biased sender observing the true state is L is identical.

[16] Therefore, the probability a left biased sender i reports the truth in period 1 when the true state is R, is denoted as q_i^R dropping the reference to the time period.

[17] The intuition for these expressions can be described as follows: when the left-biased sender reports the truth in period 1, the decision maker observes two concordant messages if the opponent is unbiased, or is right-biased, or is left-biased but is reporting the truth. This happens with probability $[p + \frac{(1-p)}{2} + \frac{(1-p)}{2} q_{-i}^R]$. In this case the decision maker follows the advice of sender i with probability $\nu_1^{i,R,R}$ and that of sender $-i$ with probability $\nu_1^{-i,R,R}$, where the superscripts R, R denote the fact that the decision maker is observing two messages suggesting the true state is R. The payoff is negative because the left-biased sender suffers a loss as messages suggest implementing decision R. With probability $\frac{1-p}{2}(1-q_{-i}^R)$ the opponent is left-biased and is lying. Then, the decision maker faces two conflicting messages, one suggesting the true state is R coming from sender i, the other suggesting the true state is L coming from sender $-i$, and she implements the decision suggested by sender i with probability $\nu_1^{i,R,L}$ leading to a loss for that sender (this explains the negative sign), or the decision suggested by sender $-i$ with probability $\nu_1^{-i,R,L}$ and this benefits a left-biased sender i. The second and the third lines represent expected continuation

By examining payoffs, it can be seen that the presence of a second sender generates two effects. There is a reduced influence effect both in the current period and in the future. Reduced future influence implies that a biased sender who maintains his reputation, will not be able to influence the decision maker for sure in the second period. So it is less important to be trusted and this reduces incentives for building a reputation for being an honest adviser. This can be seen by noting that the expected continuation payoff from reporting the truth

$$\delta E(B)[\frac{(1-p)}{2}q^R_{-i}(\nu_2^{i,L,L}+\nu_2^{-i,L,L})+p(\alpha(\nu_2^{i,L,L}+\nu_2^{-i,L,L})-(1-2\alpha)+\alpha(\nu_2^{i,L,R}-\nu_2^{-i,L,R}))+ \frac{(1-p)}{2}(\nu_2^{i,L,R}-\nu_2^{-i,L,R})+\frac{(1-p)}{2}(1-q^R_{-i})]$$

is smaller than $\delta E(B)$, the continuation payoff from telling the truth in the one sender case, as

$$\frac{(1-p)}{2}q^R_{-i}(\nu_2^{i,L,L}+\nu_2^{-i,L,L})+p(\alpha(\nu_2^{i,L,L}+\nu_2^{-i,L,L})-(1-2\alpha)+\alpha(\nu_2^{i,L,R}-\nu_2^{-i,L,R})) +\frac{(1-p)}{2}(\nu_2^{i,L,R}-\nu_2^{-i,L,R})\frac{(1-p)}{2}(1-q^R_{-i})<1$$

On the other hand, reduced current influence softens the temptation to deplete own reputation because the sender might not be able to influence first period decision either, as the decision maker follows the advice of sender i with probability $\nu^{i,m_i,m_{-i}} \leq 1$. In other words, reduced current influence decreases the opportunity cost of keeping own reputation. Therefore reduced future influence and reduced current influence determine opposite effects on truthtelling incentives.

Competition also has a lost reputation effect: if a biased sender lets competitors gain influence, he expects decisions against his preferences more than half of the times. This is represented by the expected continuation payoff from lying:

$$[-\frac{1-p}{2}(1-q^R_{-i})-(1-2\alpha)p]\delta E(B)<0$$

which can be interpreted as the cost of a lost reputation. In any equilibrium with information transmission, this term is smaller than zero which is the continuation value by lying in the one sender case[18]. The balance between the reduced influence (current and future), and the lost

payoffs, while equation 2 represents the payoff from lying and all can be understood following the same logic. Both equations have been simplified relying on the fact that

$$p_{-i,2}=\frac{p}{p+\frac{1-p}{2}q^R_{-i}+\frac{(1-p)}{2}}$$

and on the fact that a right-biased sender reports the truth when the true state is R, setting $z_1^R=1$

[18]Notice that the sign of this effect depends upon the assumptions about the action preferred by the decision maker when she is uninformed. Assuming that $\alpha>\frac{1}{3}$, implies that the decision maker prefers to randomize between actions L and R when uninformed, which yields a payoff of zero to biased senders. If instead $\alpha<\frac{1}{3}$, the decision maker would choose action C when uninformed, and the cost of a lost reputation would be larger under

reputation effect determines whether competition increases or reduces truthtelling incentives.

In order to characterize the equilibrium with two senders, it is necessary to analyze the behavior of the decision maker. Lemma 2 showed that when the decision maker observes a message suggesting decision C should be implemented and another message suggesting decision L or R, she knows the true state is C, as no biased sender prefers decision C. However, when the decision maker observes a message suggesting action L and a message suggesting action R, she cannot extract any information about the true state of the world. The equilibrium behavior of the decision maker in such a case is shown in the following:

Lemma 3 *1. In equilibrium the decision maker always randomizes between messages when she observes conflicting messages L and R from senders with the same reputation. 2. There cannot exist truthtelling equilibria when the decision maker always follows the advice of a given sender.*

Proof. See the appendix ■

It is now possible to prove the following

Proposition 2 *In the first period, if prior reputation is large enough,* $p > \frac{1-2\alpha}{2(1-\alpha)}$, *there exists a truthtelling equilibrium in which a biased sender: 1. Reports the truth in pure strategies when the true state coincides with his preferences. 2. When the true state does not coincide with his preferences, he reports the truth in pure strategies if the true state is* C, *otherwise, he reports information truthfully in pure strategies when the importance of the decision is not too large, in particular* $B < \delta E(B)[\frac{1}{2} - p(\frac{1}{2} - \alpha)] \equiv B_2^*$ *, he reports information truthfully in mixed strategies, with probability* $q^* = \frac{2[\delta E(B)(1-(1-\alpha)p)-B]}{\delta E(B)(1-p)}$ *if the importance of the decision is intermediate, in particular:* $B_2^* \equiv \delta E(B)[\frac{1}{2} - p(\frac{1}{2} - \alpha)] < B < \delta E(B)[1-(1-\alpha)p] \equiv B_2^{mix}$. *If prior reputation is "intermediate",* $\frac{1-2\alpha}{3-2\alpha} < p < \frac{1-2\alpha}{2(1-\alpha)}$ *there can only be truthtelling in mixed strategies with probability* q^* *as long as* $B_2^* < B < B_2^{mix}$. *Truthtelling incentives decrease as the bias gets stronger.*

Proof. See the appendix ■

The intuition is analogous to that of the one sender game: if period importance is low enough, it pays to give up current period payoffs to retain influence on future decisions. If period importance is larger, it is optimal to report information truthfully only at times. Finally, if period importance is very high, it is optimal to influence the decision maker in the current period as the stakes are high and it is unlikely that future decisions will be even more important.

The discussion so far makes it possible to investigate whether competition fosters truthtelling incentives. The following proposition summarizes one of the main results of the paper.

Proposition 3 *Competition has ambiguous effects on truthtelling incentives.*

no competition. When $\alpha = \frac{1}{3}$, she is indifferent among the three states.

Proof. See the appendix ■

If the true state is C, competition has a beneficial effect as aggregating information ensures the decision maker learns about the true state of the world. If instead the true state of the world does not coincide with the "unbiased state", the proposition shows that when there is truthtelling in pure strategies under competition there always is truthtelling in pure strategies with one sender only, and if the probability senders are honest is large enough, there are levels of period importance such that there is no truthtelling under competition (not even in mixed strategies) and truthtelling in pure strategies with one sender. Therefore, competition for influence can reduce the incentives of biased senders to report the truth. Truthtelling incentives are greatest if a sender is certain that his effort to gain influence on future decisions will not be jeopardized by the analogous effort of another player. However the fear the other sender will gain influence on future decisions and turns these against own preferences generates incentives to preserve credibility to influence future decisions. Moreover, the presence of a second sender reduces the value of a current deviation and this softens the temptation to give up reputation to enjoy current payoff. The balance among these effects determines whether competition raises truthtelling incentives.

4 Delegating authority - delegation and favoritism

Previous discussion made clear how the interplay of two forces (reduced current and future influence, and lost reputation effect) shapes truthtelling incentives when the decision maker cannot commit to follow the advice of a specific sender. This section investigates whether organizational design can be used to improve matters for the decision maker. In particular, delegating decision-making powers to a sender could be one way of retaining the lost reputation effect while softening reduced future influence. In order to achieve this, the decision maker needs to be able to commit to implement the decision proposed by one sender. A way to reach a credible commitment is to delegate authority to make decisions. decision-making powers can be awarded to a sender for as long as he maintains his reputation. When the latter is depleted the agent is fired and another agent gets the authority to decide in the second period. Intuitively this might be beneficial because it eliminates the reduced future influence effect and raises incentives for maintaining a reputation in the future. However, this policy increases the gains from a deviation in the current period. I consider two possibilities. The first is "delegation", the second is "favoritism". Delegation implies that $\nu_1^i = 1$, $\nu_1^{-i} = 0$, under the assumption that $p^i = p^{-i} = p > \frac{1-2\alpha}{2(1-\alpha)}$, so that player i denotes the influential sender. If he does not lie in the first period, $\nu_2^i = 1, \nu_2^{-i} = 0$, and the opposite otherwise. Favoritism allows for the possibility that the decision maker commits to follow the advice of sender i with a given probability $\nu_1^i < 1$ in the first period, and to delegate decision-making to one of the senders in the last period, so as to preserve future influence. This can be regarded as a form of favoritism, as the decision maker biases the competition for influence in favour of one of the senders. According to this definition, delegation can be regarded as a special form of favoritism.

Notice that in both delegation and favoritism, the strategy of the decision maker is not contingent on the observed messages as the decision of the influential sender can not be overturned: the decision maker credibly committed to delegate decision-making powers to that sender. If the decision maker could overturn the influential sender decision, the equilibrium would be the same as in the communication case. An important aspect to stress is what the set of available contracts is. The only assumptions needed are that the decision maker cannot overturn the decision chosen by the influential sender after observing the reports and that senders cannot be fined for a wrong report. Then contracts can be made contingent on different variables. Firstly, a contract could just state that decisions in the first period are made by sender i. Then after a correct report in the first period, the decision maker is indifferent between letting sender i influence second period decision or remove him. Alternatively, contracts can be contingent on the importance of the decision. Then delegation could be implemented by stating that an agent will be delegated powers (in both the current and the future period) as a function of current period importance: this will take care of equilibrium behavior of biased senders. Finally, a contract could state that a sender can fully influence decisions and if he is fired after the first decision, the principal (the decision maker) has to pay penalties for breaching the contract. This is self enforcing because the sender would prefer to fire the agent and pay the fine only when the first decision was wrong.[19] This is very similar to a severance payment system.

I am assuming the decision maker can fully commit not to renegotiate the contract offered. However, it is interesting to examine whether such contracts are renegotiation proof. The influential sender would need a payment of $2B$ to accept to overturn the decision, so the benefit for the decision maker has to be larger than this quantity. Moreover, the possibility of renegotiation would reduce incentives for a biased non-influential sender to report information truthfully: in fact when reports do not coincide, the biased non-influential sender might induce the decision maker to overturn the influential sender decision. Hence, the decision maker will have to pay $2B$ and will implement the correct decision only with probability $p + \frac{(1-p)}{2}q + \frac{(1-p)}{2}z$. This might not be in the interest of the decision maker. In particular, delegation is renegotiation proof if period importance for the decision maker is perfectly correlated to that for senders.

I start by analyzing whether (full) delegation leads to stronger truthtelling incentives than communication does. Suppose the sender is left-biased (the right-biased case is analogous). If the true state is L, he will report the truth. When the true state is either C, or R, a left-biased sender i reports the truth when delegated authority if and only if:

$$V_T^i = -B + \delta E(B) > V_L^i = B + \delta E(B)[\frac{1-p}{2} + \alpha p - (1-2\alpha)p - \alpha p - \frac{1-p}{2}]$$

[19] Provided, of course, the fine is not too large.

which requires:

$$B < \frac{\delta E(B)[1 + p(1 - 2\alpha)]}{2} \equiv B^{del}$$

It is interesting to notice that truthtelling incentives increase as the bias gets stronger. This follows because the lost reputation effect gets larger. In fact, if the bias is stronger, (α smaller), it is more costly to jeopardize own reputation as in expected terms, the decision maker will be influenced to make a decision against biased sender i in the future period. Notice also that mixed strategy equilibria here exists only for a set of parameters whose joint occurrence is a measure zero event. The following proposition shows in what circumstances delegation is optimal.

Proposition 4 *When the true state is either L or R, delegating decision powers to one sender induces stronger truthtelling than letting senders compete for influence*

Proof. See the appendix ■

The proof shows that there are values of period importance such that there is truthtelling in pure strategies under delegation, while under communication with two senders there is truthtelling in mixed strategies only. Furthermore, if the probability the opponent is honest is large enough ($p > \frac{1}{3-4\alpha}$), there is truthtelling under delegation, while there is not even truthtelling in mixed strategies under communication with two senders. Delegating decision powers to an agent amounts to letting the agent influence the decision both in the first and in the second period if he does not jeopardize his reputation. Thus, delegation protects influence. On the other hand, if the influential sender destroys his reputation, he will not have any chance to influence the decision maker in the future and newcomers will have full decision powers. In every equilibrium with information transmission both senders must have a large enough prior reputation. Thus each sender thinks the opponent is relatively more likely to be honest. Therefore the fear that future decisions will be influenced by an agent with opposed interests raises truthtelling incentives.

Hence, the relative benefits and costs of delegation as opposed to communication, are to be identified along two dimensions. Delegation protects influence while maintaining discipline. The dark side of delegation is obvious: firstly, under competition, the decision maker is certain to implement the correct action, whenever the true state requires coincides with the unbiased action; secondly, the influential sender has unfettered ability to implement his preferred action in the current period.

A way to overcome the latter problem is to delegate power with probability less than one in the first period. This is what I define as "favoritism". Then, assume, without loss of generality, that sender i is delegated decision powers in the second period, provided he reports information truthfully in the first period. Call sender i the "influential sender". The policy consists in offering the influential sender the following contract: the decision he proposes is implemented with probability $\frac{1}{2} < \nu_1^i < 1$ in the first period. The probability ν_1^i can be regarded as the degree of favoritism and as ν_1^i is close to one, the degree of favoritism is said to be "strong". If the report turns out to be correct, the sender gets full decision powers in the second period. Formally $\nu_2^i = 1$ if $m_{i,1} = y_{i,1}$, $\nu_2^i = 0$ otherwise. It is assumed the decision maker commits to following the advice of each sender with probability ν_1^i and $\nu_1^{-i} = 1 - \nu_1^i$, and that the probability senders are honest is large enough so as to ensure information transmission occurs in equilibrium. Under favoritism players can behave asymmetrically: in fact, when the influential sender finds it optimal to report information truthfully, a biased non-influential sender prefers to lie in the first period as he will not have any chance to influence second period decision. On the other hand, he might tell the truth, when the influential sender is lying, provided that current period importance is not too large. Thus, it is possible to prove the following

Proposition 5 *Favoritism induces stronger truthtelling incentives for the influential sender than delegation. It induces stronger truthtelling incentives than communication when the true state is either L or R. When favoritism is strong, a biased non-influential sender chooses to report the truth for intermediate realizations of period importance.*

Proof. See the appendix. ■

Favoritism allows the decision maker to provide the influential sender with stronger truthtelling incentives. On the other hand, the non-influential sender might lie, and a wrong decision suggested by the non-influential sender is implemented with positive probability. When the degree of favoritism is strong[20], a biased non-influential sender reports the truth for intermediate importance realizations.

5 Decision maker payoff

Previous discussion made clear how competition for influence shapes truthtelling incentives. This section investigates the conditions ensuring the decision maker prefers communication over delegation.[21] This choice depends upon four factors. The first is truthtelling incentives, the second is the distribution of period importance for the decision maker, the third is the distribution of period importance for senders, the fourth is the distribution of the states of the world. In fact, the more likely the unbiased state, the more communication is likely to lead to a larger payoff for the decision maker. On the other hand, if the unbiased state is more likely, truthtelling incentives under delegation become stronger.

In order to establish whether decision maker payoff is larger under delegation or under communication, it is crucial to distinguish two cases: in the first the decision maker chooses whether to delegate decision powers to one sender or to rely upon communication, after observing first

[20]The degree of favouritism is a choice variable of the decision maker who will set ν_1^i so as to maximize her expected payoff.

[21]The comparison with favouritism is similar, it just involves more tedious algebra.

period importance (both for himself and for the senders), but before senders propose a decision; in the second, the decision maker chooses communication or delegation before observing the realization of first period importance. The main intuition can be gained from the analysis of the first case. When the decision maker chooses organizational form after observing the realization of first period importance, the optimality of communication as opposed to delegation depends exclusively upon truthtelling incentives and the distribution of period importance for the decision maker. Then, it is possible to prove the following

Proposition 6 *Communication leads to a larger payoff for the decision maker if period importance for senders is low. When period importance is intermediate, or high, delegation can be preferred to communication.*

Proof. See the appendix ∎

The first part of the result refers to the case when there is truthtelling in pure strategies both under delegation and under communication. In such a case, the latter is preferred. The main reason is that communication allows to fully exploit the presence of a non biased action and the conflict of interest between senders with opposed bias. On the contrary, when period importance is intermediate or high, delegation can be preferred to communication thanks to the stronger truthtelling incentives it induces.

This analysis underlines that truthtelling incentives can be interpreted as incentives for biased senders to pool with honest senders. Delegation can increase such incentives, thus delaying learning about senders' type. Notice that if the decision maker attaches the same importance to decisions as senders do, truthtelling occurs for decisions that the decision maker does not regard as especially important. As truthtelling incentives represent conditions under which biased types pool with honest, the decision maker learns senders types when it is more costly for him to do so. Essentially, the decision maker cannot hedge against agency conflicts, so that when her period importance is very positively correlated with that for senders she may prefer to learn as quickly as possible about senders' types. In this case truthtelling incentives might be negative as they reduce learning about a sender's type.

A further effect arises when the decision maker has to choose between relying on communication or on delegation before knowing the realization of first period importance: now, the distribution of first period importance for senders plays a role. Intuitively, the distribution of period importance for senders attributes different weights to regions where there is truthtelling under delegation and no truthtelling under communication, etc. In order to provide further results it is necessary to make specific assumptions on the distribution of period importance for the decision maker and that for senders. However, overall, these results indicate that the optimality of delegation as opposed to communication essentially depends upon the importance of the decision for senders.

6 Promoting a junior

Previous discussion showed that the decision maker can raise truthtelling incentives by delegating decision powers to a sender elected as "more influential". Delegation is beneficial because it protects influence while maintaining discipline. The more the influential sender fears the opponent is honest, the more discipline there will be. It is thus interesting to extend the model and analyze a situation in which one sender already has an established reputation (the senior), while the other is promising, but still has to prove his qualities (the junior). This is modelled by assuming that one sender has a larger prior probability of being honest, although both have enough reputation to ensure truthtelling occurs in equilibrium. Suppose, without loss of generality, that player s (the senior) is more likely to be honest ex ante. Thus the lost reputation effect will be stronger if player j (the junior) is chosen as the influential sender. The decision maker faces an interesting trade off: on the one hand, delegating power to the player with the more established reputation yields a larger probability to get truthful reporting in both periods because it is more likely that he is honest; on the other hand, a biased sender has stronger incentives to report the truth, the higher the reputation of the opponent. This is reminiscent of the result in the career concerns literature that once a player's reputation is more established its incentivizing role fades out. However, in this model, the intuition is very different as it is rather the reputation of the opponent that acts as an incentive mechanism. This can be verified by inspecting the condition for truthtelling for biased senders, under delegation. This is

$$B < \frac{\delta E(B)[1 + p^{-i}(1 - 2\alpha)]}{2} \equiv \widehat{B}^i$$

if the senior is delegated powers, $p^{-i} = p^j$, while if the junior is delegated decision powers, $p^{-i} = p^s$ and it is clear that if $p^s > p^j$, player j has stronger incentives to report the truth in the first period than player s. The choice between a junior and a senior trades off a larger chance that a biased influential sender reports the truth in the first period, against a lower chance that the influential sender is honest. Therefore, organizations can decide to transfer powers from a senior to a junior as a function of the relative importance of period decisions. A junior has stronger incentives to behave in the first period because he has more to lose by misbehaving in early periods. In fact in this case, if the senior is appointed in the second period, it is likely he will influence decision-making against the preferences of a biased junior.

7 Competition among many senders

All the results so far rest on the assumption that the decision maker does not interact with more than two senders. This implies that each sender can be pivotal for the decision at least if the true state is different from the unbiased state. On the contrary, if there are at least three senders, all with the same reputation, there will trivially be truthtelling under communication, if, as assumed in the model so far, the decision maker cannot adjust the intensity of the action as a function of the breadth of the "consensus", or as a function of the probability the message is correct. Notice that this would be true even in a static game. In that case, there would not be any truthtelling equilibrium with two senders, while there could be a truthtelling equilibrium when at least three senders report information. To see what happens if more than two senders report information and the decision maker can adjust the intensity of the decision, suppose there are 3 senders, assume the probability p is large enough so as to sustain information transmission in equilibrium, and focus attention on the last period. It can be easily shown that the probability that, say, L is the true state, is larger upon observing three agreeing messages suggesting the true state is L, than upon observing two senders reporting state L and one sender reporting state R. If the decision maker can adjust the intensity of the action she will be more willing to take an action closer to the true state, the larger is the majority. Then, it is reasonable to think that the decision maker will be willing to put more resources on decision L in the first case, than in the second.

Thus, from now on, I assume the decision maker can adjust the intensity of the decision as a function of the breadth of the consensus among senders. In particular, assuming there are n senders, the decision maker adjusts the intensity of the action so that the payoff will be A^n and B^n in case of maximum consensus, and $A^{\frac{n}{2}+1}$, $B^{\frac{n}{2}+1}$, if there are $\frac{n}{2}+1$ concordant messages and therefore a majority of one or two messages, depending upon whether n is odd or even. However, in a truthtelling equilibrium, the decision maker knows that senders are reporting the truth. In such a case, she implements the decision suggested by all senders with the maximal intensity, and I denote payoffs as A^{full}, B^{full}. Observing at least one conflicting message is an out of equilibrium event. I assume that in such a case the decision maker adjusts decision intensity as explained above, using the fact that there is a majority of n concordant messages (for a whole of $n+1$ senders).[22]

As in the two senders model, there are not equilibria where, in case of disagreement, the decision maker always implements the suggestion of a given sender. If there is no consensus, but at least one of the conflicting messages suggests the unbiased state, then the latter is implemented, while if there are conflicting messages suggesting actions L and R and there is no majority, the decision maker randomizes. Consider the case of a left-biased sender observing the true state is R. Suppose also that there are $n+1$ senders, with n even.[23] I denote with l the number of left-biased senders, with r that of right-biased and with h that of honest senders. Then in a pure strategies truthtelling equilibrium, payoffs under communication from reporting the truth and

[22] This corresponds to taking an expectation about the likelihood the state reported by the majority is the true state.

[23] The case n odd is essentially analogous.

lying are given by

$$V_T = -B^{full} +$$
$$\alpha[\sum_{r=0}^{\frac{n}{2}}\sum_{l=0}^{n-r}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{l+r}\delta E(B^{n+1-r})+$$
$$\sum_{r=\frac{n}{2}+1}^{n}\sum_{l=0}^{n-r}\frac{n!}{l!r!(n-r-l)!}p^{n-(r+l)}(\frac{1-p}{2})^{l+r}(-\delta E(B^{r}))]$$
$$+(1-2\alpha)\{\sum_{h=1}^{n}\binom{n}{h}p^{h}(\frac{1-p}{2})^{n-h}(-\delta E(B^{f})+(\frac{1-p}{2})^{n}[\sum_{r=0}^{\frac{n}{2}}\binom{n}{r}(\delta E(B^{n+1-r})-\sum_{r=\frac{n}{2}+1}^{n}\binom{n}{r}(\delta E(B^{r})]\}+$$
$$\alpha[\sum_{l=\frac{n}{2}}^{n}\sum_{r=0}^{n-l}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{l+r}\delta E(B^{l+1})+$$
$$\sum_{l=0}^{\frac{n}{2}-1}\sum_{r=0}^{n-l}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{l+r}(-\delta E(B^{n-l}))] \quad (3)$$

and

$$V_L = -B^{n} +$$
$$\alpha[\sum_{r=0}^{\frac{n}{2}-1}\sum_{l=0}^{n-r}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{l+r}\delta E(B^{n-r})+$$
$$\sum_{r=\frac{n}{2}+1}^{n}\sum_{l=0}^{n-r}\frac{n!}{l!r!(n-r-l)!}p^{n-(r+l)}(\frac{1-p}{2})^{l+r}(-\delta E(B^{r}))]$$
$$+(1-2\alpha)\{\sum_{h=1}^{n}\binom{n}{h}p^{h}(\frac{1-p}{2})^{n-h}(-\delta E(B^{f})+(\frac{1-p}{2})^{n}[\sum_{r=0}^{\frac{n}{2}-1}\binom{n}{r}(\delta E(B^{n-r})-\sum_{r=\frac{n}{2}+1}^{n}\binom{n}{r}(\delta E(B^{r})]\}+$$
$$\alpha[\sum_{l=\frac{n}{2}+1}^{n}\sum_{r=0}^{n-l}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{l+r}\delta E(B^{l})+$$
$$\sum_{l=0}^{\frac{n}{2}-1}\sum_{r=0}^{n-l}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{l+r}(-\delta E(B^{n-l}))] \quad (4)$$

The expressions follow the same reasoning as in the two senders case and by noting that senders are "drawn" from a trinomial distribution, with parameters n, p, $\frac{1-p}{2}$. A more thorough explanation for these equations is provided in the appendix. The main effects of competition highlighted in the two senders version of the model are still at work. There is a reduced future influence effect, as the sender does not know whether he will be able to influence next period decision. In fact, there can be a majority of right-biased senders, or the true state can be different from L and there can be a majority of honest senders. On the other hand, there is a lost reputation effect, as next period decision could be influenced by right-biased senders, or the true state might be different from L and there can be a majority of honest senders. Both effects are further affected by the adjustment in action intensity: if all senders are left-biased, the intensity will be B^{n+1}, if there is one right-biased, the intensity will be B^n, etc. Similarly, the reduced current influence effect now depends upon the ability of the sender to affect the intensity of the decision. There is truthtelling in pure strategies if and only if $V_T > V_L$ which can be rewritten as

$$\begin{aligned}
& \alpha\{\sum_{r=0}^{\frac{n}{2}-1}\sum_{l=0}^{n-r}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{l+r}][\delta E(B^{n+1-r})-\delta E(B^{n-r})]\}+ \\
& \alpha\{\sum_{l=0}^{\frac{n}{2}}\binom{\frac{n}{2}}{l}p^{\frac{n}{2}-l}(\frac{1-p}{2})^{l+\frac{n}{2}}[\delta E(B^{\frac{n}{2}+1+l})]\}+ \\
& (1-2\alpha)(\frac{1-p}{2})^n\sum_{r=0}^{\frac{n}{2}-1}\binom{n}{r}[\delta E(B^{n-r+1})-\delta E(B^{n-r})]+ \\
& (1-2\alpha)(\frac{1-p}{2})^n\binom{n}{\frac{n}{2}}\delta E(B^{\frac{n}{2}+1})+ \\
& \alpha\{\sum_{l=\frac{n}{2}+1}^{n}\sum_{r=0}^{n-l}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{(l+r)}[\delta E(B^{l+1})-\delta E(B^{l})]\} \\
& +\alpha\{\sum_{r=0}^{\frac{n}{2}}\binom{n}{\frac{n}{2}+r}p^{\frac{n}{2}-r}(\frac{1-p}{2})^{r+\frac{n}{2}}[\delta E(B^{\frac{n}{2}+1})]\} \\
> \; & B^{full}-B^n
\end{aligned}$$

Now, it can be seen that competition induces a further "consensus" effect: if the sender lies in the current period, he changes the decision from B^{full} to B^n. Similarly, keeping a reputation allows the intensity of the decision to be increased when this is favorable, and to decrease it when it is unfavorable. Thus, the choice between giving up own reputation and giving up current period payoff will depend upon the interplay of the reduced influence, discipline and consensus effects. The latter contributes to determine both the magnitude of the opportunity cost of keeping own reputation and the strength of the future benefit of keeping own reputation. In fact, if the difference $(B^{full} - B^n)$ is very small, the sender will not be able to modify much the intensity of the decision in the current period. The benefit of keeping own reputation will depend upon the likelihood next period decision accords to the preferences of the sender. This crucially depends upon the probability distribution of types and upon the strength of the change in intensity of the action when the majority gets larger. The latter creates a new dimension to be analyzed also when discussing delegation of authority: the decision maker might delegate decision powers, while constraining the ability to set decision intensity. Denoting the latter as B^d, the payoff of a left-biased sender who is delegated authority and the state is different from L is

$$\begin{aligned} V_T &= -B^d + \delta E(B^d) \\ V_L &= B^d + \delta E(B^d)[\frac{1-p}{2} + \alpha p - (1-2\alpha)p - \alpha p - \frac{1-p}{2}] \end{aligned}$$

This follows as it is assumed the proportion of honest, left-biased and right-biased is the same in the sample of n senders. Then, there is truthtelling as long as

$$B^d < \frac{\delta E(B)[1 + p(1-2\alpha)]}{2} \equiv B^{del}$$

Whether delegation or communication leads to stronger truthtelling incentives depends upon the parameters of the problem, and it is necessary to impose more structure on the model to get a precise threshold.[24] However, it is clear that in principle either organizational form could be superior, and the main insight of the two senders model carry forward to the n senders case extended to the possibility that the decision maker adjusts the intensity of the decision. This is formalized in the following

Proposition 7 *All effects highlighted in the two senders case are still present if n senders compete for influence and the decision maker can adjust the intensity of the decision.*

Proof. See the appendix. ■

8 Discussion

This section discusses the role of the main assumptions, the modelling strategy, and applications of the model.

8.1 Assumptions and modelling strategy

The model captures, in a parsimonious way, the effects of introducing competition in a dynamic game of information transmission when the bias of senders is not known. The set up of the model is quite standard, and alternative ways to model the bias of senders (such as in Sobel 1985, or in Benabou and Laroque 1992) would not alter the main results.

The assumption that one action is not preferred by any biased type plays a role. In this (relatively) simple model, without an unbiased action and without the possibility for the decision maker to adjust the intensity of the action, the reduced current and future influence and the lost reputation effects would exactly compensate each other. However, this is a special feature of the

[24]For example, it is necessary to establish how the difference $B^n - B^{n-1}$ evolves as n changes, as well as how large this is in comparison with B^d.

simple set-up used here. On the other hand, this assumption makes communication with multiple senders naturally more attractive, as biased senders would always report information truthfully when observing the state corresponding to the unbiased action.

An important element that deserves further discussion is that senders observe perfectly the state of the world. This impacts on the dynamics of reputation: once a sender makes a mistake his reputation is gone. If he observed the state imperfectly, a mistake could be attributed to him receiving a wrong message, rather than to opportunistic behavior. In that case, reputation would evolve more realistically over time as, for example, in Benabou and Laroque (1992). Furthermore, the assumption reduces the scope for information aggregation: if the state of the world was observed noisily, aggregating the messages of multiple senders would increase the precision of the information received, even if some senders reported information strategically. This is clearly an important element, but its inclusion would complicate substantially the analysis preventing a clear investigation of the other effects generated by competition (reduced influence and lost reputation effect).

8.2 Applications

The model lends itself to the analysis of situations characterized by the presence of experts who can provide information relevant for sound decision-making and who are interested in influencing the decision-making process. The leading application is the analysis of the interaction among managers competing for corporate resources. Managers (the experts) observe information relevant to determining the most appropriate decision to maximize firm profits, or financial ratios, or other measures of performance. For example one manager can be very knowledgeable about domestic operations while another manager about overseas operations. The state of the world can be the state of the economy: if the domestic economy is very strong, the central management of the firm (the decision maker) should allocate more resources to the domestic operations department, but not if the overseas economy is growing strongly. If global markets are stagnating, the firm should allocate resources neither to domestic, nor to overseas operations. Biased managers prefer resources to be allocated in the area in which they are stronger so that they are more likely to impress the central management, irrespective of the state of the economy. The central management observes whether the information provided was correct, and evaluates the reliability of managers for future decisions. The central management can choose to collect information from managers and decide on the appropriate corporate strategy, or can delegate decisions to one of the managers, say, the head of domestic operations. The results of the paper show that delegation can improve the quality of the decision-making process.

Another interesting application is the analysis of the financing of a new technology by governmental agencies. Suppose one team of scientists is working to improve the technology to derive fuel from ethanol, while another team is working on wind energy. The government might be interested in allocating scarce funds to the project which is most likely to succeed. The government can hire different experts from the academia to assess the relative merits of the two and evaluate the one that deserves funds the most. However, some experts could be captured by agricultural lobbies supporting ethanol as it would boost the value of corn crops, while other experts could be captured by corporations producing components for wind farms. The paper shows the relative benefits of consulting multiple experts as opposed to relying only on one and shows conditions under which the latter can be preferable.

The results of the paper can also be applied to the investigation of other important real world interactions such as politicians competing to be elected, lobbies trying to influence politicians, financial analysts providing information to investors, investment banks providing advice to customers.

9 Conclusion

This paper analyzed truthtelling incentives of experts competing for influence. On the one hand competition for influence determines a "reduced influence" effect both in the current and in the future period: a biased sender knows he is less likely to influence future decisions, so that he is less willing to sacrifice current payoffs to build a reputation for providing sound advice; however a biased sender is not able to enjoy the full value of a current deviation, thus the opportunity cost of maintaining a reputation is reduced. On the other hand, competition for influence determines a lost reputation effect: biased senders fear that if they deplete their reputation, other senders will influence future decisions. Finally, competition allows the decision maker to aggregate more information and this may enable, in some circumstances, the decision maker to distinguish correct reports from wrong reports. The interplay among these effects generates interesting results and offers novel insights for organizational design. The first is that the decision-making process can be less prone to errors if only one sender reports information, as competition may harm decision-making. The second result is that the quality of decision-making can be improved if one sender is delegated authority to make decisions, becoming an "influential sender". The third is that decision-making could be further improved if the decision maker biases the competition for influence: this shows favoritism can arise as an optimal way to foster truthtelling incentives. Thus, this paper provides a new theory for the allocation of authority and for the use of favoritism in organizations: they arise endogenously as rational organizational responses to the incentives created by competition to influence decision-making. The leading application of these results is the analysis of resources allocation among divisions within an organization, but the insights of the model can be applied to investigate a variety of economic interactions: politicians competing to be elected, lobbies willing to influence politicians, financial analysts providing information to investors, investment banks providing advice to corporate clients.

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Appendix - Proofs

Proof of Lemma 1

Part 1: In the last period the sender has no reputational concerns. By reporting his preferred decision he can enjoy a positive payoff, while his payoff is non-positive if he does not report his preferred decision. When he does not have enough credibility, he randomizes and the decision maker puts zero weight on the message provided.

Part 2: this is obvious as by reporting the true state of the world he enjoys a current gain without incurring any loss in reputation.[25]

Part 3: state C is less likely than the other two states when $\alpha > \frac{1}{3}$. Any strategy that attaches positive weight to this state, when the decision maker is uninformed, is strictly dominated by a strategy that randomizes between states L and R. Such strategy yields an expected payoff of zero.

Part 4: the sender will be able to credibly transmit information in period 2 if and only if $A[p_2 + \frac{(1-p_2)}{2}(-(1-2\alpha)) + \frac{(1-p_2)}{2}(-(1-2\alpha))] > 0$, which holds if $p_2 > \frac{1-2\alpha}{2(1-\alpha)}$. This follows because the sender is honest with probability p_2 and then reports the truth. With probability $\frac{1-p}{2}$ he is left-biased, and with probability α the true state is L, so he is reporting the truth, while with probability $(1-2\alpha)+\alpha$ the state is either C, or R, and the left-biased sender lies. The same reasoning describes the behavior of a right-biased sender. In period 1 the sender is able to credibly transmit information if and only if $A\{p + \frac{(1-p)}{2}[\alpha + (1-\alpha)(q_1^s - (1-q_1^s)] + \frac{(1-p)}{2}[\alpha + (1-\alpha)(z_1^s - (1-z_1^s))]\} > 0$. In order to ensure the existence of truthtelling equilibria in pure strategies, it is necessary that $p > \frac{1-2\alpha}{2(1-\alpha)}$. In fact, in such a case, both types of biased senders report the truth in the first period setting $q_1^s = z_1^s = 1$, so that $p_2 = p$ and information can be credibly transmitted if and only if $p_2 > \frac{1-2\alpha}{2(1-\alpha)}$.

Proof of Lemma 2

Part 1: This follows from the fact that when senders have enough credibility, the expected payoff from following their advice is larger than that from making decisions without information.

[25] Furthermore, it never pays to lie by falsely reporting the true state is the unbiased state C. This follows because the sender would suffer both a current period loss, and a reputational loss. The latter is implied by the assumptions that the true state is observed perfectly. Otherwise, it could happen that a biased sender lied in order to gain a reputation for being unbiased. This mechanism would be similar to that unveiled in Morris (2001).

Thus the decision d coincides either with m_i or with m_{-i}. Moreover, when this is true, as the decision maker has a linear payoff function, it is optimal to set $\nu^{i,m_i,m_{-i}} + \nu^{-i,m_i,m_{-i}} = 1$.

Part 2: The proof is in the text.

Proof of Lemma 3

Part 1: The expected payoff by randomizing is

$$4p\frac{1-p}{2}(2(\alpha A - \alpha A)) + 2(\frac{1-p}{2})^2(2(\alpha(A-A)) - (1-2\alpha)A) = -(1-2\alpha)\frac{(1-p)^2}{2}A$$

In fact, conflicting messages L and R can occur when the decision maker faces an honest sender and a biased sender (this occurs with probability $4p\frac{1-p}{2}$, or when both sender are biased, but one is left-biased and the other right-biased (this occurs with probability $2(\frac{1-p}{2})^2$). The decision maker might use a strategy that implements action $k \in \{L, C, R\}$ when observing disagreeing messages L and R. In such a case, suppose the true state is L and the strategy is "implement state R when messages disagree": a left-biased sender will report the truth because he has no way to influence the decision maker. A right-biased sender, on the contrary, can decide to ensure getting the current period payoff by lying. When observing conflicting messages L and R, the decision maker knows the true state is L and will want to deviate from the proposed strategy. The same applies to strategies prescribing to choose C when observing messages L and R. The decision maker gets $-(1-2\alpha)\frac{(1-p)^2}{2}A$ by randomizing while she gets $4p\frac{1-p}{2}(-A) + 2\frac{(1-p)^2}{4}(1-4\alpha)A$ by choosing C. The latter follows because if there is at least one honest sender, and messages are L and R, by choosing decision C, the decision maker surely implements a wrong action. If both senders are biased, and messages are conflicting, expected payoff by choosing action C is $(1-2\alpha)A - 2\alpha A$. It can be seen that $-(1-2\alpha)\frac{(1-p)^2}{2}A > 4p\frac{1-p}{2}(-A) + \frac{(1-p)^2}{2}(1-4\alpha)A$ is always verified when there is information transmission (i.e. $p > \frac{1-2\alpha}{2(1-\alpha)}$). It can be verified that this is also true for the lowest prior probability consistent with the existence of a mixed strategy equilibrium. With the same reasoning it is possible to rule out mixed strategies that implement action k with asymmetric probabilities.

Part 2: suppose not and suppose that when there is disagreement the action of sender i is implemented. This cannot be true if sender i suggests action L and sender $-i$ suggests action C. In general, sender $-i$ will prefer to tell the truth as she will not be able to influence the current decision, but then, in case of disagreement, the decision maker knows sender i is lying and she will prefer not to abide by the proposed equilibrium strategy.

Proof of Proposition 1

The first part was proved in Lemma 1, part 2. For the second part, the payoff of a biased sender, when the true state is different from the one he prefers, is given by

$$V_T = -B + \delta E(B)$$

if he tells the truth in the first period, and

$$V_L = B$$

if he lies in the first period. The necessary condition for a pure strategy equilibrium with truthtelling is $V_T > V_L$, which is verified when

$$B < \frac{\delta E(B)}{2}$$

The model has a continuum of mixed strategy equilibria. When the true state is C, both a left and a right-biased senders lie. As payoffs are the same, the equilibrium is symmetric and $q^C = z^C = q$, therefore, $p_2 = \dfrac{p}{p+(1-p)q}$. The posterior probability that an agent is honest should be high enough in the second period, in particular $p_2 = \dfrac{p}{p+(1-p)q} > \dfrac{1-2\alpha}{2(1-\alpha)}$ which is verified as long as $q < \dfrac{p}{(1-p)(1-2\alpha)}$ which is a necessary condition for a mixed strategy equilibrium to exist. When instead the true state is R, $z^R = 1$, and $p_2 = \dfrac{p}{p+\frac{(1-p)}{2}+\frac{(1-p)}{2}q}$, the condition $p_2 > \dfrac{1-2\alpha}{2(1-\alpha)}$ is verified as long as $q < \dfrac{p(3-2\alpha)-(1-2\alpha)}{(1-p)(1-2\alpha)}$. Such mixed strategy equilibria occur over a set of measure zero. In fact, it is a measure zero event that parameters are exactly such that the first period importance happens to be

$$B = \frac{\delta E(B)}{2}$$

Proof of Proposition 2

The first part was proved in Lemma 1, part 2. The second part regarding the behavior of a biased sender when the true state is state C was proved in Lemma 2. The rest of the second part can be proved as follows: in a pure strategy equilibrium, by definition, $q^R_{i,1} = q^R_{-i} = 1$. Also, as proved by Lemma 3, $\nu^{i,m_i,m_{-i}} = \nu^{-i,m_i,m_{-i}} = \frac{1}{2}$ where $m_i, m_{-i} = L, R$. The proof of the second part follows by comparing payoffs from lying and telling the truth and imposing the condition $V_T > V_L$. Now consider mixed strategy equilibria. When the sender is left-biased, he is willing to randomize if the true state in the first period is R, otherwise when the true state is C, or L, there is truthtelling in pure strategies. Then q^R_{-i} has to be such that $V^i_T = V^i_L$, and to ease notation, drop the dependence of q on the observed state and on the time period. Then, by rearranging equations 1 and 2, it follows that

$$
\begin{aligned}
&[p(-\nu_1^{i,R,R} - \nu_1^{-i,R,R} - \nu_1^{i,L,R} + \nu_1^{-i,L,R}) + \\
&(\frac{1-p}{2})(-\nu_1^{i,R,R} - \nu_1^{-i,R,R} - \nu_1^{i,R,L} + \nu_1^{-i,R,L} - \nu_1^{i,L,R} + \nu_1^{-i,L,R} - \nu_1^{i,L,L} - \nu_1^{-i,L,L})]B + \\
&\delta E(B)[p(\alpha(\nu_2^{i,L,L} + \nu_2^{-i,L,L}) - (1-2\alpha) + \alpha(\nu_2^{i,L,R} - \nu_2^{-i,L,R})) + \\
&\frac{(1-p)}{2}(\nu_2^{i,L,R} - \nu_2^{-i,L,R}) + \frac{(1-p)}{2} + \frac{(1-p)}{2} + p(1-2\alpha)] \\
&= \\
&q_{-i}[(\nu_1^{i,L,R} - \nu_1^{-i,L,R} - \nu_1^{i,L,L} - \nu_1^{-i,L,L} + \nu_1^{i,R,R} + \nu_1^{-i,R,R} + \nu_1^{i,R,L} - \nu_1^{-i,R,L})\frac{1-p}{2}B + \\
&\delta E(B)(\frac{1-p}{2} + \frac{1-p}{2} - \frac{1-p}{2}(\nu_2^{i,L,L} + \nu_2^{-i,L,L}))]
\end{aligned}
$$

Plugging the equilibrium values of $\nu^{i,m_i,m_{-i}}$:

$$q_{-i} = \frac{2[\delta E(B)(1-(1-\alpha)p) - B]}{\delta E(B)(1-p)}$$

the equilibrium is clearly symmetric and therefore $q_{-i} = q_i = q$. In order for this to be an equilibrium, two additional conditions have to be met. Firstly, q has to be a well defined probability, hence $0 < q < 1$, secondly $p_2 > \frac{1-2\alpha}{2(1-\alpha)}$, i.e., second period reputation must be high enough for senders to exert influence. This implies $\frac{p}{p + \frac{(1-p)}{2} + \frac{(1-p)}{2}q} > \frac{1-2\alpha}{2(1-\alpha)}$, or $q < \frac{p(3-2\alpha) - (1-2\alpha)}{(1-p)(1-2\alpha)}$. For this to hold, it must be that $\frac{p(3-2\alpha) - (1-2\alpha)}{(1-p)(1-2\alpha)} > 0$ which implies $p > \frac{1-2\alpha}{3-2\alpha}$ (it can easily verified that $\frac{1-2\alpha}{3-2\alpha} < \frac{1-2\alpha}{2(1-\alpha)}$). The fact that the symmetric mixed strategy equilibrium is unique follows by the non-existence of asymmetric equilibria, established by Lemma 3. Thus, necessary conditions for a mixed strategy equilibrium are

$$
\begin{aligned}
p &> \frac{1-2\alpha}{3-2\alpha} \\
B &< \delta E(B)[1-(1-\alpha)p] \\
B &> \delta E(B)[\frac{1}{2} - p(\frac{1}{2} - \alpha)]
\end{aligned}
$$

Proof of Proposition 3

When the true state is C, the "unbiased" state, there is always truthtelling with two senders, while there is truthtelling with one sender only if period importance is not too large. When the true state is different from C, in the one sender case there is truthtelling (in pure strategies) if and only if

$$B < \frac{\delta E(B)}{2} \equiv B_1^*$$

In the two senders case, truthtelling in pure strategies in the first period occurs iff

$$B < \delta E(B)[\frac{1}{2} - p(\frac{1}{2} - \alpha)] \equiv B_2^*$$

Truthtelling in pure strategies occurs over a set of parameters of larger measure when there is only one sender, iff

$$\frac{\delta E(B)}{2} > \frac{\delta E(B)}{2}[1 - p(1 - 2\alpha)]$$

which is always verified as $\alpha < \frac{1}{2}$. There is truthtelling in mixed strategies with two senders if and only if

$$B < \delta E(B)[1 - (1 - \alpha)p] \equiv B^2_{mix}$$

and

$$\frac{\delta E(B)}{2} > \delta E(B)[1 - (1 - \alpha)p]$$

if and only if

$$p > \frac{1}{2(1 - \alpha)}$$

Therefore there can be parameter values for which there is truthtelling in pure strategies with one sender and truthtelling in mixed strategies with two senders and, if the probability the opponent is honest is large enough, there can even be a region of parameters such that there is truthtelling in pure strategies with one sender and no truthtelling with two senders.

Proof of Proposition 4

It can be seen that delegation generates stronger truthtelling incentives than communication in both the one and the two senders cases. In fact, it is easy to see that

$$\frac{\delta E(B)[1 + p(1 - 2\alpha)]}{2} > \frac{\delta E(B)}{2} > \frac{\delta E(B)}{2}[1 - p(1 - 2\alpha)]$$

Moreover,

$$\frac{\delta E(B)[1 + p(1 - 2\alpha)]}{2} > \delta E(B)[1 - (1 - \alpha)p]$$

if and only if $p > \frac{1}{3-4\alpha}$ so that, when the true state in the first period is different from state C, and the probability the opponent is honest is relatively large there are values of period importance for which there is truthtelling in pure strategies under delegation and not even truthtelling in mixed strategies under communication.

Proof of Proposition 5

I firstly derive conditions sustaining truthtelling for the influential and for the non-influential sender. I assume sender i is left-biased. When the true state is L he trivially reports the truth. When the true state is not L, it is important to distinguish the case when the true state is C, from that when the true state is R. In fact, in the latter case, a right-biased opponent surely reports the truth, while, if the true state is C, a right-biased sender might prefer to lie. Therefore, the expected payoff of a left-biased influential sender is given by:

$$V_T^i(C) = -\nu_1^i B + (1-\nu_1^i)[-\frac{1-p}{2}z - \frac{1-p}{2}(1-z) - p - \frac{1-p}{2}q + \frac{1-p}{2}(1-q)]B + \delta E(B) \quad (5)$$

$$\begin{aligned} V_L^i(C) &= +\nu_1^i B + (1-\nu_1^i)[-\frac{1-p}{2}z - \frac{1-p}{2}(1-z) - p - \frac{1-p}{2}q + \frac{1-p}{2}(1-q)]]B + \quad (6) \\ &\delta E(B)[\frac{1-p}{2}q + \alpha p - (1-2\alpha)p - \alpha p - \frac{1-p}{2}z] \end{aligned}$$

when the true state is C, and by

$$V_T^i(R) = -\nu_1^i B + (1-\nu_1^i)[-\frac{1-p}{2} - p - \frac{1-p}{2}q + \frac{1-p}{2}(1-q)]B + \delta E(B) \quad (7)$$

$$V_L^i(R) = +\nu_1^i B + (1-\nu_1^i)[-\frac{1-p}{2} - p - \frac{1-p}{2}q + \frac{1-p}{2}(1-q)]B + \delta E(B)[\frac{1-p}{2}q + \alpha p - (1-2\alpha)p - \alpha p - \frac{1-p}{2}] \quad (8)$$

when the true state is R. When the true state is C, the right-biased sender reports the truth with probability z, and reports his preferred state otherwise. Therefore, he retains his credibility with probability z. On the contrary, when the true state is R, a right-biased sender always reports the truth and retains his credibility. The intuition for these equations is essentially analogous to that for equations 1 and 2.

A biased non-influential sender always lies in a truthtelling equilibrium, as he will not have any chance to influence future decisions, unless the true state coincides with his preferences. Thus, when the true state is C biased non-influential senders lie (and $q = z = 0$) and a left-biased influential sender reports the truth in the first period if and only if

$$B < \frac{\delta E(B)[1 + (1-2\alpha)p]}{2\nu_1^i}$$

When the true state is R and the influential sender reports the truth, a right-biased non-influential sender reports the truth (so that $z = 1$), while a left-biased non-influential sender lies (so that $q = 0$) and a left-biased influential sender reports the truth if and only if

$$B < \frac{3 + (1-4\alpha)p}{4\nu_1^i}\delta E(B)$$

If the influential sender lies, a biased non-influential sender might prefer to report the truth.

Again it is important to distinguish the case when the true state is C from the case when the true state is R. In the former situation, both a left and a right-biased non-influential senders behave analogously. Expected payoffs for such senders are given by

$$\begin{aligned} V_T^{-i}(C) &= -\nu_1^i Bp - (1-\nu_1^i)B + \delta E(B)(1-p) - (1-2\alpha)p\delta E(B) \\ V_L^{-i}(C) &= -\nu_1^i Bp + (1-\nu_1^i)B - (1-2\alpha)p\delta E(B) \end{aligned}$$

The continuation payoff follows because with probability $\frac{(1-p)}{2} + \frac{(1-p)}{2} = (1-p)$ the influential sender is either left, or right-biased, and lies in the first period, so that the non-influential sender can influence second period decision. On the contrary, with probability p, the influential sender is honest, reports the truth in the first period and influences second period decision leading to an expected payoff of $-(1-2\alpha)p\delta E(B)$. The payoff from lying can be understood analogously. Therefore, biased non-influential senders are willing to report the truth if and only if

$$B < \frac{\delta E(B)(1-p)}{2(1-\nu_1^i)}$$

If the true state is R a right-biased sender always reports the truth, while a left-biased sender has the following expected payoff functions:

$$\begin{aligned} V_T^{-i}(R) &= -\nu_1^i Bp - (1-\nu_1^i)B + \frac{1-p}{2}\delta E(B) - (1-2\alpha)p\delta E(B) - \frac{1-p}{2}\delta E(B) \\ V_L^{-i}(R) &= -\nu_1^i Bp + (1-\nu_1^i)B - (1-2\alpha)p\delta E(B) - \frac{1-p}{2}\delta E(B) \end{aligned}$$

and he is willing to report the truth if and only if

$$B < \frac{\delta E(B)(1-p)}{4(1-\nu_1^i)}$$

According to the degree of favoritism (the parameter ν_1^i), there can exist two equilibria. When the true state is C, a biased influential sender reports the truth in the first period as long as

$$B < \frac{\delta E(B)[1+(1-2\alpha)p]}{2\nu_1^i}$$

and lies otherwise, while non-influential senders always lie if

$$\frac{\delta E(B)(1-p)}{2(1-\nu_1^i)} < \frac{\delta E(B)[1+(1-2\alpha)p]}{2\nu_1^i}$$

which is verified as long as

$$\nu_1^i < \frac{1+p-2\alpha p}{2(1-\alpha p)}$$

When this condition is not verified, in equilibrium the biased influential sender reports the truth as long as

$$B < \frac{\delta E(B)[1 + (1 - 2\alpha)p]}{2\nu_1^i}$$

and lies otherwise, while biased non-influential senders lie when

$$B < \frac{\delta E(B)[1 + (1 - 2\alpha)p]}{2\nu_1^i}$$

and report the truth for

$$\frac{\delta E(B)[1 + (1 - 2\alpha)p]}{2\nu_1^i} < B < \frac{\delta E(B)(1 - p)}{2(1 - \nu_1^i)}$$

Similarly, when the true state is R, there exists an equilibrium where the influential sender reports the truth as long as

$$B < \frac{3 + (1 - 4\alpha)p}{4\nu_1^i}\delta E(B)$$

and lies otherwise, and a left-biased non-influential sender always lies. Such equilibrium occurs when

$$\frac{\delta E(B)(1 - p)}{4(1 - \nu_1^i)} < \frac{3 + (1 - 4\alpha)p}{4\nu_1^i}\delta E(B)$$

which is verified when

$$\nu_1^i < \frac{3 + (1 - 4\alpha)p}{4(1 - \alpha p)}$$

When this condition is not satisfied, in equilibrium the biased influential sender reports the truth as long as

$$B < \frac{3 + (1 - 4\alpha)p}{4\nu_1^i}\delta E(B)$$

and lies otherwise. A left-biased non-influential sender lies when

$$B < \frac{3 + (1 - 4\alpha)p}{4\nu_1^i}\delta E(B)$$

and reports the truth for

$$\frac{3 + (1 - 4\alpha)p}{4\nu_1^i}\delta E(B) < B < \frac{\delta E(B)(1 - p)}{4(1 - \nu_1^i)}$$

A biased influential sender has stronger incentives to report the truth than under either delegation or communication. In fact,

$$\frac{\delta E(B)[1 + (1 - 2\alpha)p]}{2\nu_1^i} > \frac{\delta E(B)[1 + p(1 - 2\alpha)]}{2} > \frac{\delta E(B)}{2}[1 - p(1 - 2\alpha)]$$

as $\nu_1^i \leq 1$, and

$$\frac{3+(1-4\alpha)p}{4\nu_1^i}\delta E(B) > \frac{\delta E(B)[1+p(1-2\alpha)]}{2} > \frac{\delta E(B)}{2}[1-p(1-2\alpha)]$$

Moreover, the non-influential sender reports the truth if he is honest, and biased non-influential senders may report the truth according to the whether the state of the world coincides with their preferences and to the degree of favoritism.

Proof of Proposition 6

The proposition can be proved by comparing payoffs for the decision maker for different realizations of period importance.

1. If $B \in [\underline{B}, B_2^*]$, there is truthtelling in pure strategies both under communication and under delegation. In this case expected payoff for the decision maker under communication is

$$U_{Comm}^{DM} = p^2[A+\delta E(A)] + 4p\frac{(1-p)}{2}[A+(1-\alpha)\delta E(A)] + (\frac{1-p}{2})^2[4A - 2(1-2\alpha)\delta E(A))]$$

while that under delegation is

$$\begin{aligned} U_{Del}^{DM} &= p^2[A+\delta E(A)] + 2p\frac{(1-p)}{2}[A+\delta E(A)] + 2p\frac{(1-p)}{2}[A-(1-2\alpha)\delta E(A)] + \\ &\quad (\frac{1-p}{2})^2[4A - 4(1-2\alpha)\delta E(A))] \end{aligned}$$

The intuition for these expressions is as follows: with probability p^2 both senders are honest and report the truth no matter the state and period importance. Then, the decision maker implements the correct decision ensuring a payoff of A in the first period, and an expected payoff of $\delta E(A)$ in the second. With probability $p\frac{1-p}{2}$, one sender is honest, and the other is biased and as the latter can be left or right-biased, the total number of such cases is four. Period importance is low enough so that there is truthtelling in pure strategies in the first period, and payoff is A both under delegation and under communication. In the latter case expected second period payoff is $(1-\alpha)\delta E(A)$, because with probability $(1-2\alpha)$ the true state is C, and the decision maker observes a C message from the honest sender and a non C message from the biased sender, and learns the true state is C. With probability α the true state accords with the preferences of the biased sender and the decision maker observes two agreeing messages and implements the correct decision. Finally, with probability α the true state is opposed to the preferences of the biased sender and the decision maker observes conflicting messages and randomizes, so that expected payoff is zero. Under delegation, if the honest sender is delegated decision powers, second period decision is made correctly, otherwise, it is correct only when the true state is the one preferred by the biased sender, and this happens with probability α. In the other cases, the biased sender implements a wrong decision yielding an expected payoff of $-\delta E(A)$. Finally, with probability $(\frac{1-p}{2})^2$ both senders are biased, either left or right. They report the truth in the first period as period importance is lower than B_2^*, while they lie in the second period. Under communication, there can be 2 cases: both senders have the same bias, or they have opposed biases. In the latter case, which occurs with probability $2(\frac{1-p}{2})^2$, the decision maker observes conflicting messages and randomizes. In the former case, which occurs with probability $2(\frac{1-p}{2})^2$, the decision maker observes agreeing messages and implements the decision preferred by senders. That is correct with probability α and wrong with probability $(1-\alpha)$. Under delegation the decision is correct with probability α and wrong with probability $(1-\alpha)$. It is easy to verify that $U_{Del}^{DM} - U_{Comm}^{DM} = -4\frac{1-p}{2}(1-2\alpha)\delta E(A) - 2(\frac{1-p}{2})^2(1-2\alpha) < 0$, so that communication leads to a larger payoff for the decision maker.

2. If $B \in [B_2^*, \min\{B_2^{mix}, B^{del}\}]$ there is truthtelling in pure strategies under delegation, and truthtelling in mixed strategies under communication, unless the true state is zero. Payoffs for the decision maker are:

$$\begin{aligned}
U_{Comm}^{DM} &= p^2[A+\delta E(A)] + 4p\frac{(1-p)}{2}\{(1-\alpha)[A+(1-\alpha)\delta E(A)] + \alpha[q[A+(1-\alpha)\delta E(A)] + \\
&\quad (1-q)\delta E(A)]\} + (\frac{1-p}{2})^2\{2[(1-\alpha)(A-(1-2\alpha)\delta E(A)) + \alpha((q^2(A-(1-2\alpha)\delta E(A)) + \\
&\quad 2q(1-q)(-(1-2\alpha)\delta E(A)) + (1-q)^2(-A))] + \\
&\quad +2[(1-2\alpha)A + 2\alpha qA + 2\alpha(1-q)(-(1-2\alpha)\delta E(A)))]\}
\end{aligned}$$

$$\begin{aligned}
U_{Del}^{DM} &= p^2[A+\delta E(A)] + 2p\frac{(1-p)}{2}[A+\delta E(A)] + 2p\frac{(1-p)}{2}[A-(1-2\alpha)\delta E(A)] + \\
&\quad (\frac{1-p}{2})^2[4A - 4(1-2\alpha)\delta E(A))]
\end{aligned}$$

The intuition for these expressions can be understood following the same logic as above. Then,

$$\begin{gathered}
U_{Del}^{DM} - U_{Comm}^{DM} = 4p\frac{(1-p)}{2}[\alpha A(1-q) - (1-2\alpha+\alpha^2(1-q))\delta E(A)] + \\
(\frac{1-p}{2})^2[8\alpha A(1-q) - 2(1-2\alpha)(1-\alpha(1-q^2))\delta E(A)] = \\
\frac{(1-p)}{4}[8\alpha A(1-q) - (8p(1-2\alpha+\alpha^2(1-q) + 2(1-p)(1-2\alpha)(1-\alpha(1-q^2)))\delta E(A)]
\end{gathered}$$

In order to investigate the sign of this expression, it is necessary to plug q^* in. However, q^* is function of B and $\delta E(B)$, and it is necessary to make assumptions about the correlation between B and A.

3. When $p > \frac{1}{3-4\alpha}$ and $B \in [B^{mix}, B^{del}]$ there is truthtelling under delegation, and no truthtelling under communication if the state is not zero. Payoffs for the decision maker then

are:

$$\begin{aligned} U^{DM}_{Comm} &= p^2[A+\delta E(A)] + 4p\frac{(1-p)}{2}[(1-\alpha)(A+(1-\alpha)\delta E(A)) + \alpha\delta E(A)] + \\ &(\frac{1-p}{2})^2[(2(1-\alpha)(A-(1-2\alpha)\delta E(A)) + 2\alpha(-A) + 2(1-2\alpha)A - 2(2\alpha((1-2\alpha)\delta E(A)))] \end{aligned}$$

$$\begin{aligned} U^{DM}_{Del} &= p^2[A+\delta E(A)] + 2p\frac{(1-p)}{2}[A+\delta E(A)] + 2p\frac{(1-p)}{2}[A-(1-2\alpha)\delta E(A)] + \\ &(\frac{1-p}{2})^2[4A - 4(1-2\alpha)\delta E(A))] \end{aligned}$$

The intuition for these expression can be gained following the same logic as above. It can be shown that:

$$U^{DM}_{Del} - U^{DM}_{Comm} = 4p\frac{(1-p)}{2}[\alpha A - (1-\alpha)^2\delta E(A)] + (\frac{1-p}{2})^2(8\alpha A - 2(1-2\alpha)(1-\alpha)\delta E(A))$$

it can be seen that this expression is positive as long as

$$A > \delta E(A)\frac{(1-\alpha)(1-2\alpha+2\alpha p)}{4\alpha}$$

and this can occur over the feasible set for parameters.

4. When $p < \frac{1}{3-4\alpha}$ and $B \in [B^{del}, B^{mix}]$ there is truthtelling in mixed strategies under communication and no truthtelling under delegation. Then payoffs are

$$\begin{aligned} U^{DM}_{Comm} &= p^2[A+\delta E(A)] + 4p\frac{(1-p)}{2}\{(1-\alpha)[A+(1-\alpha)\delta E(A)] + \alpha[q[A+(1-\alpha)\delta E(A)] + \\ &(1-q)\delta E(A)]\} + (\frac{1-p}{2})^2\{2[(1-\alpha)(A-(1-2\alpha)\delta E(A)) + \alpha((q^2(A-(1-2\alpha)\delta E(A)) + \\ &2q(1-q)(-(1-2\alpha)\delta E(A)) + (1-q)^2(-A))] + \\ &+2[(1-2\alpha)A + 2\alpha qA + 2\alpha(1-q)(-(1-2\alpha)\delta E(A)))]\} \end{aligned}$$

$$\begin{aligned} U^{DM}_{Del} &= p^2[A+\delta E(A)] + 2p\frac{(1-p)}{2}[A+\delta E(A)] + 2p\frac{(1-p)}{2}[-(1-2\alpha)A + \delta E(A)] + \\ &(\frac{1-p}{2})^2[4(1-\alpha)(-A-(1-2\alpha)\delta E(A)) + 4\alpha(A-(1-2\alpha)\delta E(A))] \end{aligned}$$

The intuition for these expression follows the same logic as above. The difference in payoffs is:

$$\begin{aligned} U^{DM}_{Del} - U^{DM}_{Comm} = 4p\frac{(1-p)}{2}[-(1-2\alpha+\alpha q)A + (\alpha(2-\alpha) - \alpha(1-\alpha)q)\delta E(A)] + \\ (\frac{1-p}{2})^2[-8(1-2\alpha+\alpha q)A - 2(1-2\alpha)(1-\alpha(1-q^2))\delta E(A)] = \\ \frac{(1-p)}{4}[-8(1-2\alpha+\alpha q)A + 8p(\alpha(1-\alpha)(1-q))\delta E(A) - \\ 2(1-p)(1-2\alpha)(1-\alpha(1-q^2))\delta E(A)] \end{aligned}$$

Again, in order to check the sign of this expression it is necessary to plug in for q and this requires making specific assumptions about the correlation between A and B.

5. Finally, if $B \in [\max\{B^{del}, B^{mix}\}, \overline{B}]$ biased senders have no incentives for truthtelling neither under delegation, nor under communication unless the state is zero. Payoffs for the decision maker in such a case are

$$\begin{aligned} U^{DM}_{Comm} &= p^2[A+\delta E(A)] + 4p\frac{(1-p)}{2}[(1-\alpha)(A+(1-\alpha)\delta E(A)) + \alpha\delta E(A)] + \\ &\quad (\frac{1-p}{2})[(2(1-\alpha)(A-(1-2\alpha)\delta E(A)) + 2\alpha(-A) + 2(1-2\alpha)A - 2(2\alpha((1-2\alpha)\delta E(A))] \end{aligned}$$

$$\begin{aligned} U^{DM}_{Del} &= p^2[A+\delta E(A)] + 2p\frac{(1-p)}{2}[A+\delta E(A)] + 2p\frac{(1-p)}{2}[-(1-2\alpha)A + \delta E(A)] + \\ &\quad (\frac{1-p}{2})^2[4(1-\alpha)(-A-(1-2\alpha)\delta E(A)) + 4\alpha(A-(1-2\alpha)\delta E(A))] \end{aligned}$$

The intuition for these expression is similar to that of the previous cases. Then, it is easy to see that

$$U^{DM}_{Del} - U^{DM}_{Comm} = 4p\frac{(1-p)}{2}[\alpha(1-\alpha)\delta E(A) - (1-2\alpha)A] + (\frac{1-p}{2})^2[-8(1-2\alpha)A - 2(1-\alpha)(1-2\alpha)\delta E(A)]$$

This expression is positive as long as

$$A < \delta E(A)\frac{[2\alpha(1+p) - (1-p)](1-\alpha)}{8p(1-2\alpha)}$$

and this can occur over the feasible set for parameters.

Proof of Proposition 7

In the one sender case, the payoff from reporting the truth is

$$V_T = -B^{full} + \delta E(B^1)$$

while that from lying is

$$V_L = B^{full}$$

The gain from lying in the current period is $2B^{full}$, the expected payoff from exerting influence in the future is $\delta E(B^1)$, the expected future payoff if own reputation is depleted is zero.

In the n senders case, the gain from lying in the current period is

$$B^{full} - B^n$$

Thus, competition reduces current influence as

$$2B^{full} > B^{full} - B^n$$

The expected future payoff from keeping own reputation is

$$\alpha[\sum_{r=0}^{\frac{n}{2}}\sum_{l=0}^{n-r}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{(l+r)}\delta E(B^{n+1-r}) -$$
$$\sum_{r=\frac{n}{2}+1}^{n}\sum_{l=0}^{n-r}\frac{n!}{l!r!(n-r-l)!}p^{n-(r+l)}(\frac{1-p}{2})^{(l+r)}\delta E(B^{r})]$$
$$+(1-2\alpha)\{\sum_{h=1}^{n}\binom{n}{h}p^h(\frac{1-p}{2})^{n-h}(-\delta E(B^f) +$$
$$(\frac{1-p}{2})^n[\sum_{r=0}^{\frac{n}{2}}\binom{n}{r}(\delta E(B^{n+1-r}) - \sum_{r=\frac{n}{2}+1}^{n}\binom{n}{r}(\delta E(B^r)]\} +$$
$$\alpha[\sum_{l=\frac{n}{2}}^{n}\sum_{r=0}^{n-l}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{l+r}\delta E(B^{l+1}) -$$
$$\sum_{l=0}^{\frac{n}{2}-1}\sum_{r=0}^{n-l}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{l+r}\delta E(B^{n-l})]$$

Firstly, it should be noticed that when the true state is C, it is sufficient one honest sender to influence the decision away from a left-biased sender preferences. Furthermore, the decision goes against the interests of a left-biased sender when the true state is R and there is not a majority of left-biased senders, when the true state is one and there is a majority of left-biased senders, or when the true state is C and there are no honest senders and a majority of right-biased senders. This shows the sender will not be able to cash in the benefit of keeping own reputation with probability one, although it is not possible to directly compare those benefits with the payoff in the one sender case because the expected intensity of the action is typically different from the intensity corresponding to that in the one sender case (which would correspond to a majority of one sender). However, again, if the intensity of the action does not increase too much when the consensus increases by n to $n+1$, future influence is reduced under competition.

A benefit of keeping own reputation is the ability to influence next period decision towards own interests by changing the majority, so that a favorable decision will be "more favorable" and an unfavorable decision will be dampened. When own reputation is lost, in the one sender case expected payoff is zero, while with n senders it is given by

$$\alpha[\sum_{r=0}^{\frac{n}{2}-1}\sum_{l=0}^{n-r}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{(l+r)}\delta E(B^{n-r})+$$
$$\sum_{r=\frac{n}{2}+1}^{n}\sum_{l=0}^{n-r}\frac{n!}{l!r!(n-r-l)!}p^{n-(r+l)}(\frac{1-p}{2})^{(l+r)}(-\delta E(B^{r}))]$$
$$+(1-2\alpha)\{\sum_{h=1}^{n}\binom{n}{h}p^{h}(\frac{1-p}{2})^{n-h}(-\delta E(B^{f})+(\frac{1-p}{2})^{n}[\sum_{r=0}^{\frac{n}{2}-1}\binom{n}{r}(\delta E(B^{n-r})-\sum_{r=\frac{n}{2}+1}^{n}\binom{n}{r}(\delta E(B^{r})]\}$$
$$+\quad \alpha[\sum_{l=\frac{n}{2}+1}^{n}\sum_{r=0}^{n-l}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{(l+r)}\delta E(B^{l})+$$
$$\sum_{l=0}^{\frac{n}{2}-1}\sum_{r=0}^{n-l}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{(l+r)}(-\delta E(B^{n-l}))]$$

and again the decision goes against a left-biased sender preferences in the same situations as above. An additional difference is that now n is even, so having lost own reputation prevents the left-biased sender to be pivotal in those situations. Here it is possible to say something more, as

$$\sum_{l=0}^{\frac{n}{2}-1}\sum_{r=0}^{n-l}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{(l+r)}(-\delta E(B^{n-l}))=$$
$$-\sum_{r=0}^{\frac{n}{2}-1}\sum_{l=0}^{n-r}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{(l+r)}\delta E(B^{n-r})$$

and

$$\sum_{r=\frac{n}{2}+1}^{n}\sum_{l=0}^{n-r}\frac{n!}{l!r!(n-r-l)!}p^{n-(r+l)}(\frac{1-p}{2})^{(l+r)}(-\delta E(B^{r}))=$$
$$-\sum_{l=\frac{n}{2}+1}^{n}\sum_{r=0}^{n-l}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{(l+r)}(+\delta E(B^{l}))$$

furthermore

$$\sum_{r=0}^{\frac{n}{2}-1}\binom{n}{r}(\delta E(B^{n-r}) = \sum_{r=\frac{n}{2}+1}^{n}\binom{n}{r}(\delta E(B^{r})$$

so that the lost reputation effect is

$$(1-2\alpha)\{\sum_{h=1}^{n}\binom{n}{h}p^{h}(\frac{1-p}{2})^{n-h}(-\delta E(B^{f}) < 0$$

and it affects truthtelling incentives as in the two senders game.

Illustration of Equations 3 and 4.

If the sender reports the truth in a truthtelling equilibrium, current period payoff is $-B^{n+1}$ as all $n+1$ senders are reporting the same message. Then in the second period the true state is L with probability α. There will be a majority of messages suggesting state L as long as there are no more than $\frac{n}{2}$ right-biased senders. This is captured by the term

$$\sum_{r=0}^{\frac{n}{2}}\sum_{l=0}^{n-r}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{(l+r)}\delta E(B^{n+1-r})$$

With probability $(1-2\alpha)$ the true state is C. If there is at least an honest sender, he reports the truth and the decision maker knows the true state is C and sets the intensity to the maximum, denoted as B^{full}. If there is no honest sender, the decision depends upon whether the majority is left or right-biased. The former case occurs with probability $(\frac{1-p}{2})^{n}\sum_{r=0}^{\frac{n}{2}}\binom{n}{r}$ and the expected payoff is given by $(\frac{1-p}{2})^{n}\sum_{r=0}^{\frac{n}{2}}\binom{n}{r}(\delta E(B^{n-r})$, because there is a majority of left-biased senders and decision L is implemented. The latter case occurs with probability $(\frac{1-p}{2})^{n}\sum_{r=\frac{n}{2}+1}^{n}\binom{n}{r}$, and the expected payoff is given by $-\sum_{r=\frac{n}{2}+1}^{n}\binom{n}{r}(\delta E(B^{r})$ because there is a majority of right-biased senders and decision R is implemented. Then, with probability α the true state is R. With probability $\sum_{l=\frac{n}{2}+1}^{n}\sum_{r=0}^{n-l}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{l+r}$ there is a majority of left-biased senders who induce the decision maker to choose action L, with intensity $\delta E(B^{l+1})$, while with probability $\sum_{l=0}^{\frac{n}{2}-1}\sum_{r=0}^{n-l}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{l+r}$ there is a majority either of unbiased, or of right-biased senders, and decision R is implemented with intensity $\delta E(B^{n-l})$. The payoff from lying can be understood analogously. It should be noticed that when sender i lies, the total number of credible senders in the second period is n. Then, if the true state of the world in the second period is L, (this occurs with probability $(1-2\alpha)$, decision L is implemented when there is a majority of either left-biased or of unbiased senders, and this occurs with probability $\sum_{r=0}^{\frac{n}{2}-1}\sum_{l=0}^{n-r}\frac{n!}{l!r!(n-r-l)!}p^{n-(l+r)}(\frac{1-p}{2})^{l+r}$. It can be seen that when there are $\frac{n}{2}$ left-biased or unbiased senders, and $\frac{n}{2}$ right-biased senders, the decision maker observes exactly the same number of conflicting messages and she randomizes, while, if the $(n+1)^{th}$ sender reported the truth in the first period, he could be pivotal and create a majority of messages suggesting decision L. The other terms can now be easily understood, and I omit a detailed explanation.

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