Influence through ignorance

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An individual (the leader) with free access to information decides how much public evidence to collect. Conditional on this information, another individual with conflicting preferences (the follower) undertakes an action that affects the payoff of both players. In this game of incomplete but symmetric information, we characterize the rents obtained by the leader due to his control of the generation of public information. These rents capture the degree of influence *exerted by a chairman on a committee due to his capacity to keep discussions alive or call a vote. Similar insights are obtained if the leader decides first how much private information he collects, and then how much verifiable information he transmits to the follower.*

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1 Motivation

How can I induce a rational individual whose preferences are different from mine to take actions that are close to my own interests? One possibility builds on the (by now classical) asymmetric information paradigm, where an agent strategically uses his private knowledge to obtain some "rents" (possibly at the expense of other agents).[1] Another possibility builds on the related yet slightly different idea of "information control," where an individual without private information influences other people's decision by strategically choosing the amount of evidence that becomes available to every agent in the economy (including himself). The goal of this paper is to analyze this second possibility. In other words, the paper focuses not on the rents that an agent may get from his *possession of private information*, as is already well-known, but rather on the rents arising from his mere ability to *control the flow of public information*. While the economic literature has explored a number of related issues (see the review below), to our knowledge this is the first paper to specifically focus on this tool. Note that there is a fundamental difference between knowing that the other party has some information that he does not want to share and knowing that the other party has decided not to look for information: the act of no-transmission has some signalling value whereas the act of no-acquisition has no signalling value.

Situations in which one party implicitly or explicitly chooses the amount of information publicly available can be of very different nature. The archetypical example is agenda setting. Usually, one of the main roles of the chairman in a council (board of directors, Parliament, faculty recruiting committee) is to decide the moment at which consultations must stop and a decision has to be reached. Discussions elicit valuable public information. At the same time, differences in tastes imply that preferences among members are not fully congruent. The paper studies how the chairman's ability to keep the discussion alive (and let members acquire and share information about the issue at stake) or, on the contrary, terminate the debate and call a vote allows him to bias the final decision towards his preferred alternative. A similar effect operates in electoral contexts. Often, the incumbent government has the ability (within some limits) to decide the date of the

[1] Private information in strategic games has been a cornerstone of incentive theory since the 1970s. Authors have studied many games (adverse selection, signaling, cheap-talk, etc.) under different contexts (collusion, dynamics, common agency, etc.) and with multiple applications (buyer/seller, regulator/firm, government/tax payer etc.). For an introductory exposition, see Laffont and Martimort (2002).

election, reappointment or confidence vote. We show that the capacity to bring forward or postpone the event depending on whether the last few measures were well received or harshly criticized by the population will be used to influence the perception of citizens and therefore to increase the likelihood of an electoral success. Last, more controversial but also suggestive is the case of media coverage. Citizens must often rely on the news provided by media professionals in order to form their view about political events. A newspaper may influence the public opinion concerning, for example, US foreign policy in a given country without falsifying information: depending on the turn of events, it will strategically decide whether to maintain its reporters in that country and transmit the news as they occur or bring them back and stop covering the case.

In order to study this strategic game, we propose a model in which one individual with privileged access to information (the "leader", he) decides how much evidence to collect about the state of the economy. Every piece of news is automatically shared with a second individual (the "follower", she). Therefore, individuals play a game of imperfect but symmetric information, and have common beliefs at every point in time. Information acquisition is sequential. Conditional on the content of the news collected, the leader decides whether to keep adding evidence or stop the learning process. As a first step, we consider the best scenario for the leader, where he has free access to information and the follower has no access at all. Once the leader decides to stop the generation of information, the follower takes an action that affects the payoff of both players. Since the preferences of the two individuals are not congruent, the leader can and will use his access to the generation of information to his own advantage. More specifically, given that information is costless for the leader, his incentives to acquire or forego evidence depend exclusively on the likelihood that new evidence will move the belief of the follower further in the "right direction" (that is, towards the action preferred by him) vs. further in the "wrong direction". Stated differently, in this game the costs and benefits of information are two sides of the same coin: news which turns out to be good increases the expected payoff of the leader but news which turns out to be bad decreases it. The paper characterizes analytically the leader's optimal stopping rule for the generation of information and his equilibrium rents, defined as the difference between his expected utility when he decides how much information is collected and his expected utility when the follower makes that decision (Proposition 1). Naturally, the extent of this public ignorance mechanism as a tool for influence depends on several factors. We show that the ability of the leader to bias the follower's choice towards his preferred alternative increases as the leader's preferred state becomes more likely (Corollary 2) and as the preferences of both players become more congruent (Corollary 3).

We then consider two extensions of the basic model. In the first one, we assume that the leader bears a positive cost per signal acquired. In the second one, we assume that the follower can also become informed by paying some finite cost. We show that, in both cases, the leader's influence on the follower's choice is reduced but generally does not vanish. The mechanisms and implications, however, are different. When the leader's cost of gathering information is increased, he supplies less evidence, which is also detrimental for the follower (Proposition 2). By contrast, when the follower's cost is reduced, the leader supplies more evidence, which is beneficial for the follower. More precisely, the leader is induced to provide news up to the point where the follower does not have an incentive to incur the cost of restarting the learning process (Proposition 3). Note that, although in equilibrium the follower never acquires information by herself, she still benefits from her capacity to do so.

The reader might object that, in some situations, the leader first decides whether to privately collect information and then, conditional on its content, whether to make it publicly available. In other words, the game may sometimes have two stages: first, the leader collects/foregoes information, and second, the leader transmits/withholds his information to the follower. For example, newspapers first decide whether to send a reporter to investigate an affair, and then whether to publish the results of the investigation. This extension is considered in section 4. Assuming verifiable information, Milgrom and Roberts (1986) show that the leader will not be able to make a strategic use of his private knowledge. The idea is simply that the follower will adopt a skeptical, no-news-is-bad-news position: information transmitted is verified and information withheld is interpreted as negative for her interests. Since the leader cannot get rents by hiding information, the game is "as if" news collected were automatically shared with the follower. Hence, we can apply the same methodology and obtain the same results as before in the information gathering stage (Proposition 4). More generally, even in cases where payoffs can be increased through information withholding, the leader will still be able to obtain rents through information avoidance.

Before presenting the model, let us review the different areas of research related to our paper. First, the literature on "games of persuasion" is probably the most closely related to our paper. The contribution by Milgrom and Roberts (1986) has already been discussed. Matthews and Postlewaite (1985) study whether disclosure of quality tests should be mandatory. Their setting is similar to ours: a seller (our leader) chooses first whether to test product quality (our information gathering decision) and then whether to disclose the results to a buyer (our follower) who has different preferences. The paper has the interesting and counterintuitive result that the seller tests and reveals information if disclosure is not mandatory and he does not test (thus, having nothing to reveal) when disclosure is mandatory. The reason is that, under the disclosure rule, the seller can declare ignorance only if he has not tested. Such a claim must then be taken at face value. While the focus of the analysis is different, our paper also generalizes the model that they study: instead of a one-off decision whether to collect information, we consider a stream of opportunities. This way, we can analyze the optimal stopping rule, determine the maximum rents that can be obtained through public ignorance, and perform some comparative statics. Second, our analysis also relates to the literature on delegation of decision rights by an uninformed principal to one or several informed agents (Gilligan and Krehbiel (1987); Aghion and Tirole (1997); Marino and Matsusaka (2005); Aghion, Dewatripont and Rey (2004)). Contrary to this literature, we exogenously assume that one party has control over actions and, instead, we endogenize the decision of the other party to generate or avoid information. Third, the optimality of ignorance in interpersonal contexts has also been analyzed in incentive theory. Crémer and Khalil (1992) study the optimal contract designed by a principal when the agent can spend resources to privately obtain information before signing it. The trade-off from the agent's perspective is the cost of information vs. the strategic use of news. Instead, in our symmetric information setting, the decision to forego (free) evidence is based on the likelihood that news will move the beliefs of the other party towards the "desired" vs. the "undesired" direction. Fourth, Carrillo and Mariotti (2000), Bénabou and Tirole (2002) and Brocas and Carrillo (2004) have shown that an individual with time-inconsistent preferences may remain strategically ignorant about a payoff relevant variable. These papers are special cases of the present analysis, where the conflict between self-1 (leader) and self-2 (follower) arises because of the presence of the hyperbolic discounting parameter. Fifth, the paper can be viewed as a moral hazard problem where the leader's action is the amount of information gathering. In that respect, it is related to the model developed by Sobel (1993), which shows that the principal may or may not benefit from the agent being informed about the state of nature. On the one hand, an informed agent can allocate effort more effectively, thus requiring lower payment to produce. On the other hand, the agent's uncertainty allows the principal to design more efficient incentive mechanisms. Last, our paper is also related to the cheap talk literature (Crawford and Sobel, 1982). In both cases, there is strategic transmission of free information between individuals whose objectives are misaligned. The key difference lies on the reasons why information can be withheld: in cheap talk games it is assumed that one individual possesses private information whereas in our game it is assumed that one individual controls the generation of information.

The plan of the paper is as follows. In section 2, we present the model. In section 3, we characterize the rents of public ignorance enjoyed by the leader when information gathering is free and costly and when the follower can and cannot obtain information by herself. In section 4, we study an extension of the game: the leader first chooses the amount of information privately acquired and then the amount of (verifiable) information transmitted to the follower. In section 5, we conclude and suggest directions for future research.

2 A model of influence

We consider the following game. An agent (the leader, he) has free access to information about the state of the economy. However, every piece of evidence he collects becomes automatically public. Based on the news obtained by the leader and observed by the entire economy, another agent (the follower, she) undertakes an action that affects the payoff of both individuals. Since there is a conflict of preferences between the two parties, the leader can and will use his ability to collect and forego information to his own advantage.

This framework has no asymmetric information. The leader controls the flow of news but, in case of deciding to obtain some pieces of information, these are revealed to both players simultaneously. Technically, agents play a game of incomplete but symmetric information. Thus, contrary to the standard hidden information literature in which agents derive rents from their *possession of private information*, in this paper the leader will eventually get rents due to his *control of the flow of public information*. Furthermore, we assume that parties cannot contract on the information to be revealed during the game. Although non-contractibility may be inappropriate in some settings, we believe it is a reasonable assumption in the situations we have in mind. Indeed, contracts between agenda setters and committee members specifying the amount of consultations required before calling a vote and between media professionals and citizens specifying the resources to be spent on obtaining information about US foreign policy would be difficult to enforce.

Utility, actions and signals

We formalize our game of information control as follows. There are two possible states in the economy, $s \in \{A, B\}$. Individuals have imperfect but symmetric information about states. They share a prior belief $p \in (0,1)$ that the true state is A, that is, $\Pr(A) = p$ and $\Pr(B) = 1 - p$. Conditional on the information acquired by the leader during the game, the follower will choose among three possible actions, $\gamma \in \{a, o, b\}$. Given action γ, we denote by $v(\gamma)$ the utility of the follower and by $u(\gamma)$ the utility of the leader. The conflict of preferences is modeled as follows:

$$v(a) = \begin{cases} 1/\alpha & \text{if } \ s = A \\ 0 & \text{if } \ s = B \end{cases}, \quad v(o) = 1, \quad v(b) = \begin{cases} 0 & \text{if } \ s = A \\ 1/\beta & \text{if } \ s = B \end{cases} \tag{1}$$

$$u(a) = \overline{\pi}, \quad u(o) = \underline{\pi}, \quad u(b) = 0 \qquad \forall\, s \tag{2}$$

where $\overline{\pi} > \underline{\pi} > 0$. Note that the inverse of α and β represent how valuable it is for the follower to take the "correct", utility maximizing action: a in state A and b in state B, respectively. Formally, $1/\alpha = v(a|A) - v(b|A)$ and $1/\beta = v(b|B) - v(a|B)$, where $v(\gamma|s)$ denotes the follower's utility under action γ given state s. Denote by μ the posterior belief that the true state is A conditional on the information transmitted during the game. Given (1) and assuming that $0 < 1-\beta < \alpha < 1$, then the follower maximizes her expected payoff by taking action a when $\mu \geqslant \alpha$, action o when $\mu \in [1-\beta, \alpha)$, and action b when $\mu < 1-\beta$. By contrast and given (2), the leader wants the follower to take action a rather than o and action o rather b independently of the true state of the economy. This conflict of interests is graphically represented in Figure 1.[2]

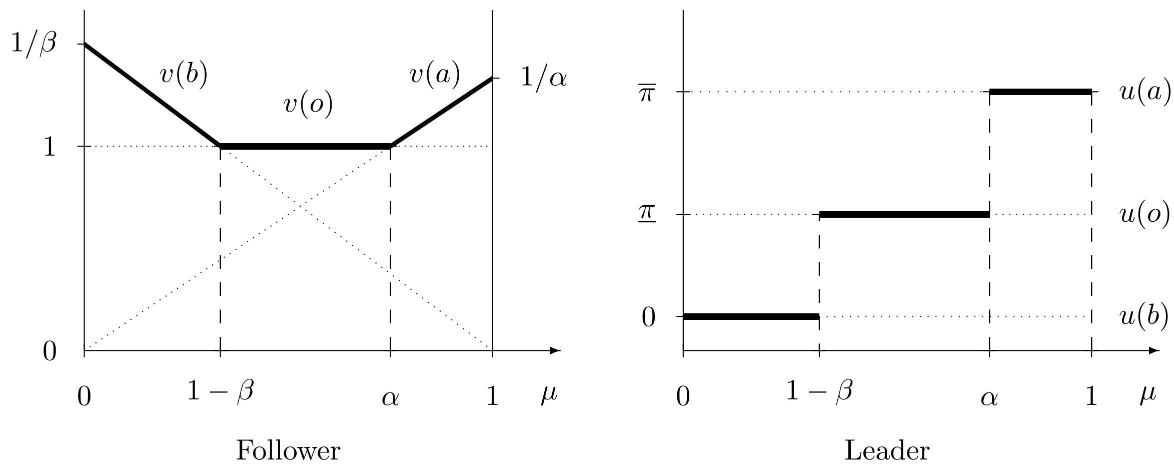

Figure 1. Payoffs of Leader and Follower.

It is important to notice that there would be no gain in generality if all payoffs of leader and follower depended on the true state. Geometrically, it would just imply a rotation of the axis in the payoff functions depicted in Figure 1, with the qualitative properties of the model remaining unchanged.

The structure of information acquisition is the following. At each moment in time, the leader (and only the leader) decides whether to generate a signal $\nu \in \{a', b'\}$ or not. There is a finite but arbitrarily large number of signals T available for collection. Signals are correlated with the true state. Formally:

$$\Pr[\, a' \mid A\,] = \Pr[\, b' \mid B\,] = \theta \quad \text{and} \quad \Pr[\, a' \mid B\,] = \Pr[\, b' \mid A\,] = 1 - \theta$$

where $\theta \in (1/2, 1)$. Note that as θ increases, the informational content of each signal ν also increases. When $\theta \to 1/2$, signals are completely uninformative. When $\theta \to 1$, one signal perfectly informs the individual about the true state. As a first step, we assume that generating information is neither costly for the leader nor produces a delay. Since

[2] We implicitly assume that in case of payoff-indifference, the follower takes the action preferred by the leader. Note also that if $0 < \alpha < 1 - \beta < 1$, action o is never optimal for the follower: she takes action a when $\mu \geqslant \alpha/(\alpha + \beta)$ and action b when $\mu < \alpha/(\alpha + \beta)$.

the number of signals collected can be arbitrarily large, the leader has the option to learn the true state almost with certainty (as $T \to +\infty$, $\mu \to 0$ if and only if $s = B$ and $\mu \to 1$ if and only if $s = A$).[3] The follower, on the other hand, has an infinite cost of generating information. These assumptions are clearly unrealistic: information is rarely free or prohibitively costly. In Propositions 2 and 3 we study what happens if the leader's cost is positive and if the follower's cost is finite.

Since it is a game of imperfect but symmetric information, the two parties (i) simultaneously update their belief using Bayes rule and (ii) share a common posterior belief at every stage of the game. Naturally, the decision of the leader whether to keep or stop accumulating evidence will be contingent on the realization of past signals.[4] Suppose that the information generated is such that a number n_a of signals a' and a number n_b of signals b' have been released. The posterior belief shared by the two individuals is:

$$\begin{aligned}\Pr(A \mid n_a, n_b) &= \frac{\Pr(n_a, n_b \mid A)\Pr(A)}{\Pr(n_a, n_b \mid A)\Pr(A) + \Pr(n_a, n_b \mid B)\Pr(B)} \\ &= \frac{\theta^{n_a - n_b} \cdot p}{\theta^{n_a - n_b} \cdot p + (1-\theta)^{n_a - n_b} \cdot (1-p)}.\end{aligned}$$

The relevant variable which will be used from now on is $n \equiv n_a - n_b \in \{-T, \ldots, T\} \subset \mathbb{Z}$, that is, the difference between the number of signals a' and the number of signals b'. This difference is bounded above and below by T and $-T$, respectively. For a given θ, we define the posterior $\mu(n) \equiv \Pr(A \mid n_a, n_b)$. Rearranging terms, we have:[5]

$$\mu(n) = \frac{1}{1 + \left(\frac{1-\theta}{\theta}\right)^n \frac{1-p}{p}}. \tag{3}$$

Note that, from a modeling viewpoint, it is equivalent to assume that the leader sequentially chooses the number of pieces of information (e.g., the time spent by a reporter to cover an event) or that information exogenously arrives and the leader chooses when to stop its flow (e.g., finish the debate and call a vote).

Information acquisition and posterior beliefs

[3] Note that the rate of convergence to the truth is exponential (see e.g. Chamley (2004), Lemma 2.1.).

[4] For recent principal-agent models that compare simultaneous vs. sequential acquisition of information, see Gromb and Martimort (2004) and Li (2004). These papers, however, are still based on asymmetric information with privately observed signals.

[5] Immediate properties of $\mu(n)$ are: (i) $\lim_{n \to -\infty} \mu(n) = 0$, (ii) $\lim_{n \to +\infty} \mu(n) = 1$, and (iii) $\mu(n+1) > \mu(n) \; \forall n$.

The first step to characterize the rents obtained due to the leader's ability to acquire or forego information is to determine the likelihood of reaching different beliefs conditional on the information currently available. More specifically, suppose that before releasing any signals, parties believe that A is the true state with probability $\mu(0) = p$ (from now on, we will for short say that they hold "belief p"). Fix θ, and suppose that the leader stops acquiring information when the difference of signals reaches either $n = d^+(p,\theta) \equiv d^+ \in \{1, \ldots, T\} \subset \mathbb{Z}^+$ or $n = d^-(p,\theta) \equiv d^- \in \{-T, \ldots, -1\} \subset \mathbb{Z}^-$ but never before. Denote by $p_H \equiv \mu(d^+)$ the posterior belief when the difference is d^+ and by $p_L \equiv \mu(d^-)$ the posterior belief when the difference is d^-. Given (3) and since d^- and d^+ are integers, p_L and p_H are not completely arbitrary: they can only be reached through a finite number of discrete jumps starting from p. Naturally, as the informational content of each signal decreases (θ smaller), the set of posteriors that can be reached through our discrete process increases. Also, since the difference of signals d^+ and d^- take finite values, we have $0 < p_L < p < p_H < 1$. Now, suppose for the time being that d^+ and d^-, and therefore p_H and p_L, are exogenously given. We ask the following question: what is likelihood of hitting each of these posteriors? Naturally, it crucially depends on whether the true state is A or B. Formally, denote by $q^s(p; p_L, p_H)$ the probability of reaching p_H (and not p_L) when the lower and upper boundaries are p_L and p_H, the initial belief is $p \in (p_L, p_H)$ and the true state is s. Naturally, $1 - q^s(p; p_L, p_H)$ is the probability of reaching p_L (and not p_H). Last, $q(p; p_L, p_H)$ is the unconditional probability of reaching p_H. By definition, we have $q^s(p_L; p_L, p_H) = 0$ and $q^s(p_H; p_L, p_H) = 1$ for all s. Interestingly, given our simple information acquisition game, it is possible to obtain analytical expressions of these probabilities. These are gathered in Lemma 1 and they are key for our analysis.[6]

Lemma 1. $q^A(p; p_L, p_H) = \dfrac{p - p_L}{p_H - p_L} \times \dfrac{p_H}{p}$ and $q^B(p; p_L, p_H) = \dfrac{p - p_L}{p_H - p_L} \times \dfrac{1 - p_H}{1 - p}$.
Moreover, $q(p; p_L, p_H) \equiv p \times q^A(p; p_L, p_H) + (1 - p) \times q^B(p; p_L, p_H) = \dfrac{p - p_L}{p_H - p_L}$.

Proof. Let $\Pr(A \mid n)$ be the likelihood of state A when the difference of signals is n. By definition, $\Pr(A \mid 0) = p$, $\Pr(A \mid d^+) = p_H$ $(\in (p,1))$ and $\Pr(A \mid d^-) = p_L$ $(\in (0,p))$. Denote by $\lambda^s(n)$ the probability of reaching a difference of signals d^+ before reaching a

[6] Technically, the question amounts to determine the evolution of a stochastic process with two absorbing states. Although the case of one absorbing state is common, we have not found anywhere the analytical characterization for the case of two absorbing states. We therefore prove it below.

difference of signals d^- when the current difference of signals is n and the true state is s. By definition, $\lambda^s(d^-) \equiv 0$, $\lambda^s(d^+) \equiv 1$ and $\lambda^s(0) \equiv q^s(p; p_L, p_H)$. By setting $T \to +\infty$, we can ensure that the leader will eventually reach one of the (finite) difference of signals d^+ or d^-. From the definition of the transmission of information, we have:

$$\lambda^A(n) = \theta \cdot \lambda^A(n+1) + (1-\theta) \cdot \lambda^A(n-1) \qquad \forall\, n \in \{d^- + 1, \dots, d^+ - 1\} \tag{4}$$

$$\lambda^B(n) = (1-\theta) \cdot \lambda^B(n+1) + \theta \cdot \lambda^B(n-1) \qquad \forall\, n \in \{d^- + 1, \dots, d^+ - 1\} \tag{5}$$

From (4), we have:

$$\lambda^A(n+1) - \frac{1}{\theta}\,\lambda^A(n) + \frac{1-\theta}{\theta}\,\lambda^A(n-1) = 0.$$

The generic solution to this second-order difference equation is of the form:

$$\lambda^A(n) = \kappa_1 \cdot r_1^n + \kappa_2 \cdot r_2^n,$$

where (κ_1, κ_2) are constants and (r_1, r_2) are the roots of the second order equation:

$$x^2 - \frac{1}{\theta}\,x + \frac{1-\theta}{\theta} = 0.$$

Simple calculations yield:

$$r_1 = \frac{1-\theta}{\theta} \qquad \text{and} \qquad r_2 = 1$$

In order to determine the pair (κ_1, κ_2), we use the fact that $\lambda^A(d^-) = 0$ and $\lambda^A(d^+) = 1$:

$$\lambda^A(d^-) = 0 \;\Rightarrow\; \kappa_1 \left(\frac{1-\theta}{\theta}\right)^{d^-} + \kappa_2 = 0 \quad \text{and} \quad \lambda^A(d^+) = 1 \;\Rightarrow\; \kappa_1 \left(\frac{1-\theta}{\theta}\right)^{d^+} + \kappa_2 = 1$$

Denoting $\Theta \equiv \dfrac{1-\theta}{\theta}$, these equations imply that $\kappa_1 = \dfrac{1}{\Theta^{d^+} - \Theta^{d^-}}$ and $\kappa_2 = -\dfrac{\Theta^{d^-}}{\Theta^{d^+} - \Theta^{d^-}}$, and therefore the general solution is:

$$\lambda^A(n) = \frac{1 - \Theta^{n-d^-}}{1 - \Theta^{d^+ - d^-}} \qquad \forall\, n \in \{d^-, \dots, d^+\} \tag{6}$$

Note from (4) and (5) that the case $s = B$ is obtained simply by switching θ and $1 - \theta$:

$$\lambda^B(n) = \frac{1 - (1/\Theta)^{n-d^-}}{1 - (1/\Theta)^{d^+ - d^-}} \quad \Leftrightarrow \quad \lambda^B(n) = \frac{\Theta^{d^+ - n} - \Theta^{d^+ - d^-}}{1 - \Theta^{d^+ - d^-}} \tag{7}$$

Obviously, $p \equiv \Pr(A \mid 0)$. From the definitions of $\Pr(A \mid n)$ and using (3), we have:

$$p_H \equiv \Pr(A \mid d^+) = \frac{1}{1 + \left(\frac{1-\theta}{\theta}\right)^{d^+} \frac{1-p}{p}} \quad \Leftrightarrow \quad \Theta^{d^+} = \frac{p}{1-p} \frac{1-p_H}{p_H} \tag{8}$$

$$p_L \equiv \Pr(A \mid d^-) = \frac{1}{1 + \left(\frac{1-\theta}{\theta}\right)^{d^-} \frac{1-p}{p}} \quad \Leftrightarrow \quad \Theta^{d^-} = \frac{p}{1-p} \frac{1-p_L}{p_L} \tag{9}$$

Therefore, combining (6), (7), (8), and (9), we get:

$$\lambda^A(0) = \frac{p - p_L}{p_H - p_L} \times \frac{p_H}{p} \; \Big(= q^A(p; p_L, p_H)\Big),$$

$$\lambda^B(0) = \frac{p - p_L}{p_H - p_L} \times \frac{1 - p_H}{1 - p} \; \Big(= q^B(p; p_L, p_H)\Big),$$

$$q(p; p_L, p_H) \equiv p \times \lambda^A(0) + (1-p) \times \lambda^B(0) = \frac{p - p_L}{p_H - p_L}.$$

This proof immediately extends to the well-known case of one absorbing state, in which the leader does not set a lower bound d^- where he stops acquiring information (see e.g., Chamley (2004, proposition 8.2)). The probabilities of reaching the upper bound d^+ are $q^A(p; \emptyset, p_H) = 1$ and $q^B(p; \emptyset, p_H) = \frac{1-p_H}{p_H} \times \frac{p}{1-p}$. When $s = B$, with probability $1 - q^B(p; \emptyset, p_H) = \frac{p_H - p}{p_H(1-p)}$ the leader has not reached p_H after T signals with $T \to +\infty$ and the posterior is $\mu \to 0$. *Q.E.D.*

Lemma 1 states that the probability of reaching p_H before p_L is proportional to the distance between the upper bound and the prior $(p_H - p)$ relative to the distance between the prior and the lower bound $(p - p_L)$. Recall from Figure 1 that the follower takes action a if her belief is $\mu \geqslant \alpha$. Therefore, starting from prior p $(< \alpha)$, the likelihood of reaching a posterior greater than α is higher the smaller the distance $\alpha - p$. From (1), we know that α captures the inverse of the follower's payoff of taking action a correctly. Thus, as the follower's payoff of taking action a under state A increases (i.e., as α decreases), she is relatively more likely to end up with a posterior belief in which she finds it optimal to take that action both correctly (when the state is A) and mistakenly (when the state is B). A similar argument holds for b and β.

By inspection of (3), the reader can notice that not all the posteriors in the open, convex set $(0, 1)$ can be exactly reached. Indeed as $n \in \{-T, \ldots, T\} \subset \mathbb{Z}$, the posterior belief $\mu(n)$ exhibits "jumps". Also, $\mu(n+1) - \mu(n)$ is increasing in θ and it is equal to

0 when $\theta = 1/2$. Therefore, when the informational content of each signal is arbitrarily small ($\theta \to 1/2$), the (discrete) change in belief after one signal ($\mu(n+1) - \mu(n)$ or $\mu(n-1) - \mu(n)$) is also arbitrarily small. This means that, as θ decreases, there is a finer partition of the posterior beliefs that can be reached through sampling.[7]

Note also that $q^A(\cdot) > q(\cdot) > q^B(\cdot)$ for all p_L, p_H and $p \in (p_L, p_H)$. By definition, the likelihood of obtaining a' rather than b' signals is higher when the state is A than when the state is B. Since a' signals move the belief upwards (towards A) and b' signals move it downwards (towards B), then for any prior p, it is more likely to reach the upper bound p_H before the lower bound p_L if the state is A than if the state is B. Also, $\lim_{p_L \to 0} q^A(p; p_L, p_H) = 1$ and $\lim_{p_H \to 1} q^B(p; p_L, p_H) = 0$: the leader can never believe almost with certainty that one state is true when in fact it is not. Last, suppose that there exist θ and $\tilde{\theta}$ such that $p_H = \mu(d^+; \theta) = \mu(\tilde{d}^+; \tilde{\theta})$ and $p_L = \mu(d^-; \theta) = \mu(\tilde{d}^-; \tilde{\theta})$. In words, suppose that the same posteriors can be reached after a different number of signals depending on their informational content.[8] In that case, an interesting corollary follows from the previous analysis.[9]

Corollary 1. $q^s(p; p_L, p_H, \theta) = q^s(p; p_L, p_H, \tilde{\theta})$.

This result is obtained by direct inspection of the analytical expressions derived in Lemma 1, and it may at first seem surprising. It states that the informational content of each signal (θ vs. $\tilde{\theta}$) affects the speed at which one of the posteriors (p_L or p_H) is reached but not the relative probabilities of attaining each of them. Roughly speaking, more accurate information implies greater chances of receiving the "correct" signal (a' if $s = A$ and b' if $s = B$) but also that an "incorrect" signal moves the posterior farther away in the opposite direction. These two effects cancel each other out.

[7] One way to have smooth transitions in beliefs would be to formalize the process in continuous time and with a continuous arrival of information. The model would have to be modified accordingly.

[8] From (3), if $\tilde{\theta} > \theta$, then $\tilde{d}^+ < d^+$ and $|\tilde{d}^-| < |d^-|$: a greater correlation of state and signals implies fewer number of signals needed to reach either posterior.

[9] Naturally, if θ and $\tilde{\theta}$ are taken arbitrarily, it is not necessarily true that the same posteriors can be reached starting from p. Indeed, given a correlation $\hat{\theta}$ there does not exist always an integer n such that $\mu(n; \hat{\theta}) = p_H$ due to integer problems (for example, in the most extreme case $\hat{\theta} \to 1$, we have $\mu(0) = p$, $\mu(1) \to 1$ and $\mu(-1) \to 0$).

3 Optimal control of information generation

The strategic value of public ignorance

Given the conflict of preferences between the two individuals, the leader will use his control of the flow of information to induce the follower to undertake action a rather than o or action o rather than b. As information is revealed to both players simultaneously, influence can only be achieved through the decision to stop collecting additional news. In this context, an optimal stopping rule is characterized by at most two probabilities p_L ($< p$) and p_H ($> p$) (or, equivalently, two differences of signals d^- and d^+) such that the leader stops collecting information if and only if one of these posterior beliefs is reached. Recall that $\overline{\pi}$, $\underline{\pi}$ and 0 represent the payoffs of the leader when the follower takes actions a, o and b respectively whereas $1/\alpha$ and $1/\beta$ are the payoffs of the follower under action a if the state is A and under action b if the state is B. Suppose that $p \in (1-\beta, \alpha)$. Denote by $n^+(p,\theta) \equiv n^+$ the minimum integer n such that $\mu(n) \geqslant \alpha$ and by $n^-(p,\theta) \equiv n^-$ the minimum integer n such that $\mu(n) \geqslant 1-\beta$. Denote also the corresponding posterior beliefs by $\alpha^+ \equiv \mu(n^+)$ and $(1-\beta)^+ \equiv \mu(n^-)$. Starting from p and given θ, α^+ represents the lowest attainable posterior belief such that the follower is willing to take action a. Similarly, $(1-\beta)^+$ represents the lowest attainable posterior belief such that the follower is willing to take action o. Assuming $0 < (1-\beta)^+ < \alpha^+ < 1$ and using Lemma 1, we obtain the main result of the paper.

Proposition 1. Suppose that $p \in [(1-\beta), \alpha]$. Two cases are possible:[10]
(i) If $\underline{\pi}/\overline{\pi} \leqslant (1-\beta)^+/\alpha^+$, then $p_H = \alpha^+$ and the leader does not set a lower bound. The expected utility of the leader is $U_{(0,\alpha)} = \overline{\pi}\,\frac{p}{\alpha^+}$ and the expected utility of the follower is $V_{(0,\alpha)} = p\,\frac{1}{\alpha} + \frac{\alpha^+-p}{\alpha^+}\frac{1}{\beta}$ (> 1).

(ii) If $\underline{\pi}/\overline{\pi} > (1-\beta)^+/\alpha^+$, then $p_L = (1-\beta)^+$ and $p_H = \alpha^+$. The expected utility of the leader is $U_{(1-\beta,\alpha)} = \overline{\pi}\,\frac{p-(1-\beta)^+}{\alpha^+-(1-\beta)^+} + \underline{\pi}\,\frac{\alpha^+-p}{\alpha^+-(1-\beta)^+}$ and the expected utility of the follower is $V_{(1-\beta,\alpha)} = 1 + \frac{\alpha^+-\alpha}{\alpha}\frac{p-(1-\beta)^+}{\alpha^+-(1-\beta)^+}$ $(\geqslant 1)$.

[10] For the sake of completeness, note that if $p > \alpha$, then learning is never started and the leader gets utility $\overline{\pi}$. Also, when $p < (1-\beta)$ there exists n^+ and n^- as well as α^+ and $(1-\beta)^-$ (defined in the same way as before), and two cases are possible: (i) if $\overline{\pi} > \alpha^+/(1-\beta)^+$, then $p_H = \alpha^+$, the leader sets no lower bound and his expected utility is $\overline{\pi}\,p/\alpha^+$; (ii) if $\overline{\pi} < \alpha^+/(1-\beta)^+$, then $p_H = (1-\beta)^+$, the leader sets no lower bound and his expected utility is $\underline{\pi}\,p/(1-\beta)^+$.

Proof. Since only the leader can learn, if it is optimal for him to stop learning at some point, then he will not restart it later on. Because the leader maximizes expected utility, his payoff only depends on the posterior and not on the number of signals it took to reach it. This, together with the fact that beliefs are uni-dimensional, implies that there are at most two posteriors (one above and one below the prior) where learning is stopped. Also, by allowing the stopping rules to coincide with the prior p, we embed the case where learning is never started. This proves that we can, without loss of generality, consider a maximum of two stopping posteriors, p_H ($\geqslant p$) and p_L ($\leqslant p$). The only restriction is that, given θ and p, the posteriors p_L or p_H must be reached after an integer difference of signals.

We now determine the optimal stopping rule. According to the leader's payoff given by (2), it is obvious that he will never provide information when the difference of signals is $n \geqslant n^+$ since $\mu(n) \geqslant \alpha^+$ for all $n \geqslant n^+$. Also, extra information cannot hurt him if $n \in \{n^- + 1, \ldots, n^+ - 1\}$ or if $n \leqslant n^- - 1$. The only issue left is whether he will stop when $n = n^-$, that is when $\mu = (1-\beta)^+$, or not. If the leader stops at $\mu = (1-\beta)^+$, he gets a sure payoff of $\underline{\pi}$. If he continues, then either he reaches a difference n^+ and stops or he exhausts his T signals and learns almost with certainty that $s = B$. Stopping at $\mu = (1-\beta)^+$ is optimal if and only if:

$$\underline{\pi} > \overline{\pi}\left[q((1-\beta)^+;\emptyset,\alpha^+)\right] + 0\left[1 - q((1-\beta)^+;\emptyset,\alpha^+)\right] \quad \Leftrightarrow \quad \underline{\pi}/\overline{\pi} > (1-\beta)^+/\alpha^+.$$

For each of these cases, the utility of the leader is:

$$U_{(0,\alpha)} = \overline{\pi}\left[q(p;\emptyset,\alpha^+)\right] \quad \text{and} \quad U_{(1-\beta,\alpha)} = \overline{\pi}\left[q(p;(1-\beta)^+,\alpha^+)\right] + \underline{\pi}\left[1 - q(p;(1-\beta)^+,\alpha^+)\right],$$

and the utility of the follower is:

$$V_{(0,\alpha)} = p\,\frac{1}{\alpha}\,q^A(p;\emptyset,\alpha^+) + (1-p)\,\frac{1}{\beta}\left[1 - q^B(p;\emptyset,\alpha^+)\right]$$

and

$$V_{(1-\beta,\alpha)} = q^A(p;(1-\beta)^+,\alpha^+)\,p\,\frac{1}{\alpha} + \left(1 - q(p;(1-\beta)^+,\alpha^+)\right)$$

Simple algebra gives the final outcome. *Q.E.D.*

Proposition 1 shows that the leader derives rents at the expense of the follower due to his ability to control the generation of public information. Indeed, if the follower could decide on the amount of information to be generated during the game, she would force the leader to exhaust all signals and learn the true state almost with certainty. The expected payoffs of the follower and the leader would be $V_{(0,1)} = \frac{p}{\alpha} + \frac{1-p}{\beta}$ (greater than both $V_{(0,\alpha)}$ and $V_{(1-\beta,\alpha)}$) and $U_{(0,1)} = p\,\overline{\pi}$ (smaller than both $U_{(0,\alpha)}$ and $U_{(1-\beta,\alpha)}$), respectively.

The keys to determine the leader's optimal stopping rule are the following. First, once the posterior α^+ is reached, the leader has no further incentive to keep collecting information since, under this belief, the follower takes the action that provides the greatest payoff to him. Second, the leader will never stop accumulating evidence if $\mu \in ((1-\beta)^+, \alpha^+)$: his payoff is $\underline{\pi}$ so he can, at the very least, wait until either $(1-\beta)^+$ or α^+ are hit. Third, if $\mu < (1-\beta)^+$ the leader's payoff of stopping is 0, so there is no downside in keeping the learning process active. The only remaining question is whether to stop at $\mu = (1-\beta)^+$ and obtain a payoff $\underline{\pi}$ with certainty or keep providing evidence. In the latter case, with probability $\frac{(1-\beta)^+}{\alpha^+}$ the posterior $\mu = \alpha^+$ is hit and the leader obtains a payoff $\overline{\pi}$. With probability $\frac{\alpha^+ - (1-\beta)^+}{\alpha^+}$ all signals are exhausted. Both individuals learn that the true state is B almost with certainty and the leader obtains a payoff of 0.

Note that, as the leader's payoff under action o gets closer to his payoff under action a and farther away from his payoff under action b (i.e., as $\underline{\pi}/\overline{\pi}$ increases), the value of gambling for a or b decreases relative to the value of stopping at a posterior $(1-\beta)^+$ and accepting action o: there is less to win $(\overline{\pi} - \underline{\pi})$ and more to lose $(\underline{\pi} - 0)$. More generally, the fact that information is symmetric implies that the costs and benefits of collecting information are two sides of the same coin: extra evidence may move the belief of the follower towards or against the direction preferred by the leader. Depending on the relative likelihood of these two forces and the payoffs in each case, the leader will choose whether to keep generating information or not.

Overall, the ability to control the flow of news and remain publicly ignorant gives the leader some power, which is used to influence the actions of the follower. In terms of our examples, our result suggests that the chairperson, President and media can bias the decision of the committee, electorate and public simply by strategically restricting the flow of information. It is essential to notice that the follower realizes that the leader controls the generation of information to his own advantage. However, contrary to the models of asymmetric information where no-news (i.e., no transmission of information) signals that the leader probably has bad-news, in this model no-news has no signaling value; it can only be interpreted as the leader being “satisfied” with the existing information or “fearing” what may come next. Also, and by the same token, it is never in the follower's best interest to refuse pieces of information, even if she could commit to (the follower is indifferent between accepting and refusing information only in case (ii) and when $\alpha^+ = \alpha$).

The determinants of influence

How much influence can be exerted through public ignorance is an empirical issue, interesting but beyond the scope of this paper. We would like however to perform some comparative statics in order to determine under which circumstances choice biases will be strongest. Given the previous analysis, we have the following result.

Corollary 2. When the leader can control the flow of information, his expected utility is increasing in p.

An increase in p has two effects. First and trivially, the true state is more likely to be the leader's favorite, so his expected utility increases independently of whether there is influence or not. Second and more interestingly, the same or fewer a'-signals are necessary to reach the upper cutoff where the information flow is stopped and the leader's highest payoff is obtained. This makes it easier for the leader to influence the choice of the follower, whether the true state is A or not.

Note that if $\underline{\pi}/\overline{\pi} < (1-\beta)^+/\alpha^+$, then there is no lower bound where sampling is stopped. In that case, the follower never takes action b contrary to her own best interest (when $s = A$). The likelihood that the upper bound α^+ is hit when state is B (in which case the follower takes the leader's preferred action contrary to her own best interest) is given by the following simple formula:

$$\Pr(a \mid B) = \frac{p}{1-p} \times \frac{1-\alpha^+}{\alpha^+} \tag{10}$$

This probability is increasing in p due to the second effect mentioned above. From (10), we can see that influence can, in fact, be quite substantial. For example, starting from a prior $p = 1/2$, if $\alpha^+ = 2/3$ and the state turns out to be $s = B$, then the likelihood of a wrong choice from the follower's perspective is as large as $\Pr(a \mid B) = 1/2$.

Costly information gathering by the leader

We have so far focused on the most extreme case where the leader has free access to information, and showed that he may stop the information gathering process even in that situation. The analysis can be easily extended to a more realistic setting, where the leader incurs some cost k per piece of evidence acquired. We have the following result.

Proposition 2. Suppose that $p \in [(1-\beta), \alpha]$ and $\underline{\pi}/\overline{\pi} > (1-\beta)^+/\alpha^+$. If the leader bears a cost k per unit of information collected, then $p_H(k) = \alpha^+$ and $p_L(k) \in [(1-\beta)^+, \alpha^+]$, with $p_L(k) \geqslant p_L(k') \; \forall k > k'$ and $p_L(0) = (1-\beta)^+$.[11]

Proof. Denote by $W(n)$ the value function of the leader given a difference of signals $n \in \{n^- + 1, \dots, n^+ - 1\}$. We have:

$$W(n) = \max \left\{ \underline{\pi},\ \eta(n) W(n+1) + (1 - \eta(n)) W(n-1) - k \right\}$$

where the first term in the maximization is the payoff if information is stopped and the second term is the value of collecting at least one more signal, and $\eta(n) = \mu(n)\theta + (1 - \mu(n))(1-\theta)$. We know from Proposition 1 that $\eta(n^-)W(n^- + 1) + (1 - \eta(n^-))W(n^- - 1) < \underline{\pi}$, so $W(n^-) = \underline{\pi}$ for all $k > 0$, and therefore $W(n^- + 1) \geqslant W(n^-)$. We also know from Proposition 1 that information is stopped at α^+ so $W(n^+) = \overline{\pi} > \underline{\pi}$. If there exists $n \in \{n^- + 1, \dots, n^+ - 1\}$ such that $W(n) > W(n-1) = \underline{\pi}$, then $W(n) = \eta(n)W(n+1) + (1-\eta(n))W(n-1) - k < \eta(n)W(n+1) + (1-\eta(n))W(n) - k \;\Rightarrow\; k < \eta(n)(W(n+1) - W(n)) \;\Rightarrow\; W(n+1) > W(n)$. This means that there exists n^* such that $W(n) = \underline{\pi}$ for all $n \in \{n^-, \dots, n^*\}$ and $W(n) > \underline{\pi}$ for all $n \in \{n^* + 1, \dots, n^+\}$. Thus, $p_L(k) \equiv \mu(n^*)$ (naturally, it may be that $n^* = n^+ - 1$; this corresponds to $W(n) = \underline{\pi}$ for all $n \in \{n^-, \dots, n^+ - 1\}$, in which case information is never collected). By definition, $p_L(0) = (1-\beta)^+$. Last, since the second term in the maximization is strictly decreasing in k, the value n^* and therefore the lower cutoff $p_L(k)$ is weakly increasing in k. *Q.E.D.*

The idea behind Proposition 2 is simple. We know from Proposition 1 that information is valuable for the leader only as a means to induce the follower to take action a. Therefore, just like before, sampling is stopped if the upper bound $p_H = \alpha^+$ is ever reached. Also,

[11] Note that $p_L(k) \geqslant p$ corresponds to the case where sampling is never started.

when $\underline{\pi}/\overline{\pi} > (1-\beta)^+/\alpha^+$, the leader never samples beyond $(1-\beta)^+$ due to the risk of being trapped in a posterior where the follower takes action b. The new effect introduced by considering a positive cost of sampling is that it may not be worthwhile to acquire evidence even in situations where beliefs are above $(1-\beta)^+$. Indeed, if μ is close to $(1-\beta)^+$, the chances of hitting α^+ before $(1-\beta)^+$ are small (see Lemma 1). These benefits are then outweighed by the costs of information acquisition (the large expected number of costly signals needed to reach α^+). Formally, the lower bound where sampling is stopped will be above $(1-\beta)^+$. Naturally, as the cost k of sampling increases, the net value of experimentation decreases, which translates into an increase in the lower bound p_L. For sufficiently high costs, the learning process may never be started.

Overall, under a positive cost of information, the leader still keeps and strategically uses his discretion in the collection of evidence, but his ability to influence the choice of the follower is reduced. Interestingly, given that the leader provides less information, the follower also suffers from this positive cost: as already discussed, the lack of private information in this model automatically implies that she is never better-off when she refuses information or, equivalently, when the capacity of the leader to acquire signals is reduced.

Costly information available to the follower

The basic model considers the most favorable situation for influence: the leader has free access to information (or zero cost) and the follower has no access at all (or infinite cost). In the previous section, we studied the effect of increasing the leader's cost. We now analyze what happens when the follower's cost is reduced. It is indeed plausible to assume that the follower can also affect the generation of public information. For example, committee members can spend their political capital in requesting more letters of recommendation before casting votes. Citizens can independently search for information about events of national interest, etc. We introduce this possibility in our model by assuming that, at any moment, the follower can become perfectly informed about the true state if she pays a cost c (> 0) (since only the follower undertakes an action, it is irrelevant whether the state is also revealed to the leader or not).[12] As in the basic model, the leader has no cost

[12]This technology corresponds to a cost c paid by the follower for a signal $\{a'', b''\}$ such that $\Pr[a''|A] =$

of collecting evidence. In order to avoid a multiplication of cases and problems related to n being an integer, we suppose that the follower faces a symmetric payoff situation and that the posterior α can be exactly reached after a finite number of samplings. Also, both states are ex-ante equally likely:[13]

Assumption 1. $\alpha = \beta = \alpha^+$ and $p = 1/2$.

Given that information is costly for the follower and that the leader does not have private access to it, the former will always find it optimal to wait until the latter stops providing pieces of news before deciding whether to pay the cost of becoming perfectly informed. Suppose that the leader stops the flow of information at a posterior $\mu \in (0, 1)$. It is possible to characterize the optimal continuation strategy of the follower.

Lemma 2. If $c \geqslant (1 - \alpha)/\alpha$, the follower never learns the true state. If $c < (1 - \alpha)/\alpha$, the follower learns the true state if and only if the posterior belief is $\mu \in (\alpha c, 1 - \alpha c)$.

Proof. Given Assumption 1, the payoff of the follower when she becomes informed is:

$$V_L = \frac{1}{\alpha} - c \tag{11}$$

By contrast, her payoff of not acquiring information depends on the posterior belief μ, which determines the action to be taken. We have:

$$V_N(\mu) = \begin{cases} \mu/\alpha & \text{if} \quad \mu \geq \alpha \\ 1 & \text{if} \quad \mu \in (1-\alpha, \alpha) \\ (1-\mu)/\alpha & \text{if} \quad \mu \leq 1-\alpha \end{cases} \tag{12}$$

From (11) and (12) we get that:

$$V_L > V_N(\mu) \quad \Leftrightarrow \quad \begin{cases} \mu < 1-\alpha c & \text{if} \quad \mu \geq \alpha \\ c < (1-\alpha)/\alpha & \text{if} \quad \mu \in (1-\alpha, \alpha) \\ \mu > \alpha c & \text{if} \quad \mu \leq 1-\alpha \end{cases}$$

Note that $\mu < 1 - \alpha c$ and $\mu > \alpha$ are compatible if and only if $c < (1 - \alpha)/\alpha$. Similarly, $\mu > \alpha c$ and $\mu < 1 - \alpha$ are also compatible if and only if $c < (1 - \alpha)/\alpha$. *Q.E.D.*

$\Pr[b''|B] = \tilde{\theta}$ with $\tilde{\theta} = 1$ (perfect correlation). Similar results are likely to hold under imperfect correlation ($\tilde{\theta} \in (1/2, 1)$).

[13] Note that $\beta = \alpha \ \Rightarrow \ 1 - \beta = 1 - \alpha$. Also, $p = 1/2$ and $\alpha = \alpha^+ \ \Rightarrow \ 1 - \alpha = (1 - \alpha)^+$.

When the acquisition of information is excessively costly ($c \geqslant (1-\alpha)/\alpha$), the follower strictly prefers to rely on the news disclosed by the leader, even if she anticipates his strategic use of information. The leader knows that she will not restart learning, and therefore keeps the same information gathering strategy as in Proposition 1. When information is not too costly ($c < (1-\alpha)/\alpha$), the follower chooses whether to become fully informed or not depending on her current beliefs. If she is sufficiently confident that the true state is either A or B (i.e., if $\mu \geqslant 1-\alpha c$ or $\mu \leqslant \alpha c$), then the gains of perfect information are small relative to the cost. By contrast, for intermediate beliefs (i.e., when $\mu \in (\alpha c, 1-\alpha c)$) news are highly informative, and therefore acquired.

Note that $c < (1-\alpha)/\alpha \;\Rightarrow\; \alpha c < 1-\alpha \; (= 1-\beta)$ and $1-\alpha c > \alpha$. In words, the leader knows that if he stops collecting evidence when $\mu \in \{1-\beta, \alpha\}$, as dictated by Proposition 1(ii), then the follower will for sure restart the learning process and undertake her optimal action. The anticipation of this possibility induces the leader to modify his information gathering strategy. Denote by n^{++} ($\geqslant n^{+}$) the minimum integer n such that $\mu(n) \geqslant 1-\alpha c$ and let $(1-\alpha c)^{+} \equiv \mu(n^{++})$. Our next result is the following.

Proposition 3. If $c < (1-\alpha)/\alpha$, then $p_H = (1-\alpha c)^{+}$ and the leader does not set a lower bound. The follower never restarts learning. The leader's utility is $U^c = \overline{\pi}\,\frac{1}{2(1-\alpha c)^{+}}$ ($\leqslant \min\left\{U_{(0,\alpha)}, U_{(1-\beta,\alpha)}\right\}$) and the follower's utility is $V^c = \frac{3(1-\alpha c)^{+}-1}{2\alpha(1-\alpha c)^{+}}$ ($\geqslant \max\left\{V_{(0,\alpha)}, V_{(1-\beta,\alpha)}\right\}$). Also, $\partial U^c/\partial c \geqslant 0$ and $\partial V^c/\partial c \leqslant 0$ for all $c > 0$.

Proof. If $c < (1-\alpha)/\alpha$, then $\alpha c < 1-\alpha$ and $1-\alpha c > \alpha$. Hence, the leader will never provide information when he reaches a posterior $\mu \geq 1-\alpha c$ (his payoff $\overline{\pi}$ is guaranteed) and he will always provide information if $\mu \leqslant \alpha c$ (he cannot do worse than getting a payoff of 0). When $\mu \in (\alpha c, 1-\alpha c)$, the leader has two options. First, to keep providing news until either $p_H = (1-\alpha c)^{+}$ is hit or all samplings are exhausted. This implies a payoff $\overline{\pi}\left[q(\mu; \emptyset, (1-\alpha c)^{+})\right] = \overline{\pi}\frac{\mu}{(1-\alpha c)^{+}}$. Second, to stop providing news. In this case, the follower chooses to learn the true state so the leader's payoff is $\overline{\pi} \times \Pr(A) + 0 \times \Pr(B) = \overline{\pi}\mu$. Since the payoff is always greater with the first option, it is optimal for the leader to stop only when $p_H = (1-\alpha c)^{+}$. Given the prior $p = 1/2$, the utility of the leader and the follower are:

$$U^c = \overline{\pi}\left[q(1/2; \emptyset, (1-\alpha c)^{+})\right] = \overline{\pi}\,\frac{1}{2(1-\alpha c)^{+}}$$

$$V^c = p\frac{1}{\alpha}\left[q^A(1/2;\emptyset,(1-\alpha c)^+)\right]+(1-p)\frac{1}{\alpha}\left[1-q^B(1/2;\emptyset,(1-\alpha c)^+)\right] = \frac{3(1-\alpha c)^+ - 1}{2\alpha(1-\alpha c)^+}.$$

It follows that $\partial U^c/\partial c \geqslant 0$ and $\partial V^c/\partial c \geqslant 0$. *Q.E.D.*

When the follower has the ability to acquire information and it is not excessively costly, the leader is forced to increase the amount of news released, otherwise he will not be able to influence her choices. In particular, o is never going to be selected in equilibrium: for any belief $\mu \in [1-\alpha, \alpha]$, the follower strictly prefers to pay the cost of learning the true state. Given that either a or b will be chosen, the optimal way for the leader to influence the follower's decision is to remove any lower bound at which information collection is stopped and push the upper bound up to the point where the follower is willing to take action a without restarting learning.

Overall, the follower's ability to collect information by herself reduces the leader's discretion in the provision of news, and therefore his capacity to manipulate her choices. As the follower's cost c to obtain news decreases, more signals need to be disclosed to avoid restarting the information gathering process, which implies that the expected welfare of the follower increases and the expected welfare of the leader decreases.[14] However, as long as this cost is positive, the leader will *always* derive rents from his capacity to restrict information and the follower will always suffer from it.

Interestingly, the leader makes sure that, in equilibrium, the follower never restarts the learning process. Yet, her capacity to obtain information is enough to increase her welfare at the expense of the leader. This conclusion is similar to the contract theory literature on collusion (Tirole, 1986), renegotiation (Dewatripont, 1988), and information gathering (Crémer and Khalil, 1992) for example. In these papers, the optimal contract is such that collusion, renegotiation, and acquisition of information before the contract is signed never occur in equilibrium. However, just as in our paper, the mere possibility of engaging in these practices affects the payoffs of players.[15] Last, it is possible to enrich our model in a way that the main conclusions hold and the follower sometimes restarts the acquisition of news. One possibility would be to introduce uncertainty in the follower's cost of gathering

[14] Weak monotonicity is only due to sampling being limited to natural numbers.

[15] By assumption, in Crémer and Khalil (1992) the agent obtains the information at no cost after signing the contract. The issue, however, is whether to pay a cost in order to get it before signing the contract.

information. A similar device is employed by Kofman and Lawarrée (1996) to show that collusion may be an equilibrium outcome in a model à la Tirole (1986).

4 Information acquisition and information transmission

In the model presented in section 2, we assumed asymmetric information away in order to better isolate the rents extracted due to the ability to forego evidence. However, it is often the case that the leader first decides whether to collect information and then, conditional on its content, whether to transmit it to the follower. A newspaper decides whether to send a reporter to cover a story but also whether to release or retain the information discovered. A manager usually has an easier access to information internal to the firm than an outside auditor. He then uses to his own advantage both his capacity to collect/forego *and* his capacity to transmit/withhold evidence. A counsel for the defense keeps or stops searching for evidence as a function of his current findings, but he also chooses to present to the jury favorable evidence and to conceal unfavorable one. Note that, for practical or legal reasons, in the situations described above, parties cannot contract on the amount of information to be acquired and revealed.

To capture the situations described above, we propose a two-stage variant of the model, where the leader first decides the amount of information privately acquired, and then the amount of information transmitted. Intuitively, the incentives to acquire information are now different: the act of "no news transmitted" may (and, in equilibrium, will) be interpreted by the follower as "bad news possessed". We will make the key simplifying assumption that the information acquired by the leader is verifiable. Suppose that the leader stops acquiring pieces of information when his posterior belief is $\mu \in [0, 1]$. He then provides a report $r(\mu)$ ($\subset [0, 1]$) to the follower. In formal terms, verifiability implies that the posterior belief must be contained in the report, that is, $\mu \in r(\mu)$. As it turns out, the properties of the sequential equilibrium of the information transmission stage of this game have already been studied in the literature on games of persuasion (Milgrom and Roberts, 1986). We can combine their result with our Proposition 1 to determine the equilibrium of our two-stage game.

Proposition 4. In the two-stage game with private acquisition of verifiable information, the optimal stopping rule of the leader is the same as in Proposition 1. Moreover, in every sequential equilibrium, the action taken by the follower and the payoffs of both players are also the same as in Proposition 1.

Proof. Suppose that the leader stops at a posterior belief μ and reports $R \subset [0,1]$ (with $\mu \in R$). Denote by ρ the posterior belief inferred by the follower given R.

Step 1. Suppose that $\rho = \tilde{\mu}$ iff $\nexists\, \hat{\mu} < \tilde{\mu}$ s.t. $\hat{\mu} \in R$. Milgrom and Roberts (1986, proposition 1) shows that, assuming this inference, then $\nexists\, \mu' < \mu$ s.t. $\mu' \in R$: the lower bound of the leader's report will always be his true belief.

Step 2. Using this result, Milgrom and Roberts (1986, proposition 2) then shows that, at every sequential equilibrium, the follower infers $\rho = \tilde{\mu}$ iff $\nexists\, \hat{\mu} < \tilde{\mu}$ s.t. $\hat{\mu} \in R$.

Step 3. Since for any belief μ of the leader, the report R will be such that the follower infers $\rho = \mu$, the optimal acquisition of information rule is the same as in Proposition 1, and so are the payoffs of both individuals. *Q.E.D.*

Proposition 4 states that, with private but verifiable information, the leader will not be able to affect the follower's choice by strategically manipulating the transmission of his private information. Naturally, he will be able to exert the same influence as before with the control of information generation. The idea is simple. Since the follower knows the incentives of the leader to overstate the likelihood of state A, she will adopt a "skeptical posture": always assume the worst which, in our case, corresponds to the lower bound of the report set. As a result, the leader will neither include in the report a posterior below his own belief nor be able to instil on the follower a posterior above it.[16] Since private information cannot be withheld in equilibrium, the optimal information collection strategy of the leader is the same as in section 3. An alternative lecture of this result is that public generation of news is sufficient but not necessary for influence through ignorance to occur.

The reader might find unrealistic that all the information possessed by the leader is inferred by the follower. Rents from information withholding can be restored if we relax the most restrictive assumptions of our game. Matthews and Postlewaite (1985) and Milgrom and Roberts (1986) discuss for example the case of unverifiable information.

[16] Note that the equilibrium is not unique: given a belief μ, we can only state that the leader's equilibrium strategy will contain μ as the lower bound of the report set. By contrast, the response of the follower is unique (act as if the report was μ), and so are the payoffs of both players.

Other alternatives would be to assume that the follower anticipates only partially the incentives of the leader to misreport information (i.e., to introduce bounded rationality) or to assume that players have imperfect knowledge of each other's preferences (i.e., to include a second dimension of private information). Adding these ingredients would undoubtedly make the model more realistic.

5 Conclusion

The starting point of the paper was to argue that an individual with privileged access to information can influence the decision of his peers in two fundamentally different ways. First, with his decision to hide or transmit his private information. Second, with his decision to acquire or forego additional (private or public) information. While the first mechanism builds on the classical asymmetric information paradigm and has been extensively studied in the literature, to the best of our knowledge the second mechanism has received almost no attention. The goal of our paper was to provide a first careful look to the rents that can be extracted through public ignorance.

Many other issues related to this idea deserve scrutiny. For example, in our framework, the utility of players is common knowledge. It would be interesting to study a model with several sequential actions where the preferences of the follower are private information. Our intuition is that the leader may find it optimal to stop accumulating evidence, observe the first action of the follower, deduce (perfectly or imperfectly) her preferences from her behavior and decide whether to restart the acquisition of information. As emphasized at different places in the paper, we may also learn new insights by combining information acquisition and information transmission, as in Matthews and Postlewaite (1985): how does the leader's ability to manipulate the transmission of information modify his willingness to acquire news in a first place? Another extension of interest would be to assume that the follower observes the information obtained by the leader with some positive probability, and that the latter can spend resources to decrease this probability. What would be the interplay between the leader's incentives to acquire knowledge and his incentives to hide the information? One may also wonder what will happen in this game if individuals start with different priors about the state of the world and therefore have different interpretations of the evidence generated (as, for example, in Van den Steen, 2004). Last, it would be interesting to determine under which circumstances the leader loses part or all the rents of public ignorance. Again at an intuitive level, rents may shrink or even vanish if several individuals with conflicting goals (two newspapers, a defense counsel and a prosecutor) compete to provide/withhold information. Also, if the relationship between the individuals is repeated, the follower may credibly threaten to take the action least preferred by the leader unless full information is revealed. Our hope is that these questions will stimulate further research on the subject.

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