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# Attention, coordination, and bounded recall ☆

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ABSTRACT

I consider a class of strategic interactions under asymmetric information in which, prior to finalizing their actions (consumption, production, or investment decisions), agents choose the attention to allocate to a large number of information sources about exogenous events that are responsible for their payoffs (the underlying fundamentals). I study what type of payoff interdependencies contribute to inefficiency in the allocation of attention. I then compare the results for the benchmark of perfect recall (in which the agents remember the content of individual sources) to those for bounded recall (in which the agents are unable to keep track of the influence of individual sources on posterior beliefs). More generally, the analysis illustrates the implications (for attention and usage of information) of a certain form of bounded rationality whereby the summary statistic the agents recall from the sources they pay attention to is distorted away from the optimal action towards the Bayesian projection of the exogenous fundamentals over the signals received.

## 1. Introduction

Many socio-economic interactions take place under asymmetric information about relevant economic fundamentals affecting preferences and technology. For example, firms make various real and nominal decisions under limited information about the demand for their products and/or the cost of their inputs; consumers choose consumption bundles under limited information about their future needs; traders choose portfolios under limited information about the profitability of relevant assets; voters choose candidates under limited information about their objectives and policy platforms.

The asymmetry of information reflects individual constraints on the amount of information that each single decision-maker can process. Time and cognition are limited, implying that the information that individuals use for most of their decisions is less than what is in the public domain and is typically interpreted with idiosyncratic error.

Furthermore, in many situations of interest, individuals experience difficulty in keeping track of the influence of individual sources of information on their posterior beliefs. For example, an investor reading a large number of articles about an event responsible for

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the profitability of his investment decisions (e.g., the likelihood of a war, the default of a sovereign borrower, or the collapse of a political establishment) may have difficulty remembering how his beliefs have been influenced by the specific articles he read. Such a difficulty is irrelevant when the decision-maker recalls the action maximizing his payoff given the information he processed. However, because the sources contain information about primitive events and not directly about optimal actions, when paying attention to a large number of sources, it is natural to recall a statistic tilted away from the optimal action towards the Bayesian projection of the exogenous fundamentals on the information received. The reason why the Bayesian projection may distort the agent's recollection is twofold. First and foremost, the information contained in the individual sources is about the exogenous events and not the equilibrium actions. Second, the agent may use the same information for decisions other than the one in the specific situation under consideration. Under such circumstances, it is natural (albeit often unconsciously) to summarize information into a statistic of the primitive events before distilling implications for the optimal actions.

The difficulty in recalling individual pieces of information (equivalently, the optimal action) is particularly relevant in environments in which the number of information sources is large (see, e.g., Kahneman (1973, 2011), and Kahneman et al. (1982) for studies documenting such a difficulty). Importantly, this form of bounded rationality is relevant only in games. In single decision-theoretic problems, whether the decision-maker recalls the individual content of the sources or only the Bayesian projection of the fundamentals on the information received is irrelevant. This is because optimal actions are measurable in the Bayesian statistic. Instead, in strategic settings, individual sources may correlate with the actions of other players over and above the way these actions correlate with the Bayesian projection of the exogenous fundamentals on the individual signals received. In other words, the Bayesian projection need not be an appropriate summary statistic of the individual signals when it comes to the *joint distribution* of the exogenous fundamentals and other players' actions.

In this paper, I investigate the implications (for the allocation of attention and the subsequent use of information) of a form of bounded rationality that is meant to reflect the difficulty described above. The strategic situations I consider accommodate for various types of payoff interdependencies leading to either complementarity or substitutability in actions and responsible for various inefficiencies in the allocation of attention and the subsequent equilibrium usage of information. I first revisit the case of perfect recall bringing under the same unifying umbrella results that are scattered in the literature and that have been established for specific applications. I then compare the equilibrium under perfect recall with its counterpart under bounded recall. Along the way, I discuss inefficiencies in the acquisition and usage of information and show that they originate in the discrepancy between the private and social value of reducing (a) the dispersion of individual actions around the mean action, and (b) the volatility of the average action around its first-best counterpart.

Differently from what is assumed in the rational inattention literature, I do not allow the agents to learn flexibly about the fundamentals.[2] Flexible learning is an abstraction that is useful to characterize the limits of what can be sustained across different information structures. However, it does not permit one to study the effects of bounded recall.[3] This is because, under flexible learning, the information sources are not modeled explicitly and the optimal signal is simply the optimal action, making the distinction between perfect and bounded recall irrelevant. Instead, I model explicitly the information sources as in Dewan and Myatt (2008) and Myatt and Wallace (2012), with each source defined by its accuracy and transparency. The *accuracy* of a source is the precision of its content, whereas its *transparency* is the rate of return of attention to the source, that is, the extent to which additional attention to the source leads to a marginal reduction in the idiosyncratic interpretation of its content. This formalization is particularly useful to study the effects of bounded recall. I compare the allocation of attention that emerges when agents are fully sophisticated with the one that emerges when agents recall only the Bayesian projection of the fundamentals on the information received (in the Appendix, I consider a more general version of bounded recall in which the statistic is tilted away from the equilibrium action towards the Bayesian projection by a weight that spans continuously all combinations between the two cases). The agents understand how their attention shapes the co-movement between their subsequent actions, the fundamentals, and other agents' actions. They anticipate the difficulty recalling the content of individual sources (equivalently, the optimal action) and adjust their attention to best account for such a difficulty.

The first insight is that, with bounded recall, the benefit that each agent assigns to an increase in the attention allocated to any given source combines the familiar reduction in the dispersion of his action around the mean action (as in the benchmark with perfect recall), with a novel effect that stems from the change in the distribution of the agent's own average action around its complete-information counterpart (the average is over different signals' realizations). This second effect is absent under perfect recall, and has important implications for the equilibrium allocation of attention. I show that, relative to the case of perfect recall, the agents reallocate their attention from sources of low and high endogenous publicity (these are sources of, respectively, low and high transparency) to sources of intermediate publicity.

To understand the result, observe that sources of low endogenous publicity are sources whose ratio between transparency and accuracy is low. These sources serve the agents well in predicting the exogenous fundamentals but are poor coordination devices, given that their interpretation is subject to significant idiosyncratic noise. In the case of perfect recall, paying attention to these sources is justified by the possibility of letting the sensitivity of the equilibrium actions to these sources be different from the sensitivity to other sources, thus limiting the impact of the idiosyncratic interpretation of these sources on the dispersion of individual actions around the mean action. Such a possibility is severed under bounded recall, thus reducing the benefit of paying attention to these sources. Sources

[2] See Sims (2003, 2011) for an introduction to this literature.

[3] See also Denti et al. (2022) for other difficulties that emerge when the cost of information is over the distribution of posterior beliefs or actions, instead of the selected statistical experiment.

of high publicity, instead, are sources whose ratio between transparency and accuracy is high. These sources may be imprecise when used to predict the exogenous fundamentals but serve the agents well when used to predict the forecasts, and hence ultimately the actions, of other agents. With bounded recall, however, because the agents cannot respond to these sources differently from how they respond to other sources, paying a lot of attention to these sources may lead to a high volatility of an agent's own average action (across different signal realizations) around its complete-information counterpart. Because such a volatility contributes negatively to payoffs, the benefit of paying attention to these sources is dampened relative to the case of perfect recall. Sources of intermediate publicity, instead, are *good compromises*: they are decent forecasters of both the underlying fundamentals and other agents' actions. As a result, with bounded recall, the benefit of paying attention to these sources is higher than under perfect recall. Assessing the empirical support of this prediction is fascinating but difficult because of the complexity of measuring (or even proxying for) how agents allocate their attention to a large number of information sources. However, that, in many situations of interest, agents favor information sources with an intermediate transparency/accuracy ratio seems broadly consistent with heuristics (see also the survey on the influence of economic and finance news outlets and journalists in Ragas and Tran (2015)).[4]

I conclude by investigating how bounded recall affects the (in)efficiency of the equilibrium allocation of attention. Relative to the benchmark of perfect recall, inefficiencies now originate not only in the discrepancy between the private and the social value of reducing the dispersion of individual actions around the mean action, but also in the discrepancy between the private and the social value of reducing the dispersion of individual *average actions* around their complete-information counterparts. Despite these novel effects, I show that the key normative insights from the benchmark with perfect recall carry over to the case of bounded recall. In particular, economies in which agents value coordination more than the planner typically feature an excessively high allocation of attention to sources of high endogenous publicity (which in turn are sources with a high transparency/accuracy ratio), and an excessively low allocation of attention to sources of low publicity. The opposite property holds in economies in which the planner values aligning individual actions more than the agents.

**Organization**. The rest of the paper is organized as follows. I wrap up the introduction below with a quick review of the most pertinent literature. Section 2 describes the model. Section 3 contains all results for the case of perfect recall. Section 4 contains all the results for bounded recall. Section 5 contains a broader review of the literature. Section 6 concludes. All proofs are in the Appendix at the end of the document. The online Supplement contains the proof of an additional claim in the main text.

### 1.1. Most closely related papers

As mentioned above, the information sources in the present paper are modeled as in Dewan and Myatt (2008) and Myatt and Wallace (2012). The payoff structure, instead, is the same as in Angeletos and Pavan (2007, 2009), and Colombo et al. (2014). Proposition 1, Corollary 1, and Example 1 below extend analogous results in Myatt and Wallace (2012) to the more general payoff specification considered in the present paper. Proposition 2, instead, extends results in Colombo et al. (2014) to the general information structure of Myatt and Wallace (2012). The payoff generalization is essential to the normative results, whereas the generalization of the information structure is essential to the analysis of bounded recall. In fact, the game in Myatt and Wallace (2012) is a potential game in which the potential function is utilitarian welfare (see, e.g., Monderer and Shapley (1996) for the definition of potential games). Under this specification, there are no inefficiencies in either the allocation of attention or the usage of information. The information structure in Colombo et al. (2014) features an exogenous public signal and a single uni-dimensional endogenous private signal; under this structure, the case of perfect recall coincides with the case of full recall. Examples of economies that are special cases of the general class considered in the present paper can be found in Morris and Shin (2002) (beauty contests), Angeletos and Pavan (2004) (investment spillovers), Myatt and Wallace (2014) (Lucas-Phelps economies), Myatt and Wallace (2015) (Cournot competition), and Myatt and Wallace (2018) (asymmetric and differentiated Bertrand competition). See also Bergemann and Morris (2013) and Vives (2017) for related linear-quadratic games with Gaussian noise.

## 2. Environment

**Agents, Information Sources, and Attention**. The economy is populated by a measure-one continuum of agents, indexed by $i$ and uniformly distributed over $[0,1]$. Each agent $i$ has access to $N \in \mathbb{N}$ sources of information about a primitive payoff variable $\theta$ which is responsible for the agents' payoffs (hereafter, the *exogenous fundamentals*). Depending on the application of interest, $\theta$ parametrizes a technology shock, a demand shifter, or the profitability of a new investment opportunity. Agents share a common prior that $\theta$ is drawn from a Normal distribution with mean zero and precision $\pi_\theta \equiv \sigma_\theta^{-2}$ ($\sigma_\theta^2$ is thus the variance of the distribution).[5] The information contained in each source $n = 1, ..., N$ is given by

$$y_n = \theta + \varepsilon_n,$$

[4] The article analyzes the results of a survey investigating the influence of various US financial and economics media outlets and individual journalists. According to the article, *The Wall Street Journal* and Andrew Ross Sorkin of *The New York Times* are widely perceived by peers as the most influential financial media outlet and journalist, respectively. In many ways, these sources are neither the most specialized (and hence accurate) nor the most accessible ones. Yet, they strike a good balance between accuracy and transparency and are perceived as highly influential.

[5] Hereafter, I adopt the convention of using "tildes" to denote random variables. For example, the fundamental $\theta$ is the realization of the random variable $\tilde{\theta}$ with mean zero and variance $\sigma_\theta^{-2}$. That the mean of $\tilde{\theta}$ is zero simplifies the formulas, without any important effect on the results.

where $\varepsilon_n$ is drawn from a Normal distribution, independently of $\theta$ and of any $\varepsilon_s$, $s \neq n$, with mean zero and precision $\eta_n$. By paying attention $z^i \equiv (z^i_n)_{n=1}^N \in \mathbb{R}_+^N$ to the various sources, agent $i \in [0,1]$ then receives $x^i \equiv (x^i_n)_{n=1}^N \in \mathbb{R}^N$ *private* signals, with each $x^i_n$ given by

$$x^i_n = y_n + \xi^i_n,$$

where $\xi^i_n$ is idiosyncratic noise, normally distributed, with mean zero and precision $t_n z^i_n$, drawn independently of $\theta$, $\varepsilon \equiv (\varepsilon_n)_{n=1}^N$, and $\xi^j_s$, with $s = 1, ..., N$ for $j \neq i$, and $s = 1, ..., n-1, n+1, ..., N$ for $j = i$. The parameter $\eta_n \in \mathbb{R}_+$ measures the source's *accuracy*, whereas the parameter $t_n \in \mathbb{R}_+$ its *transparency* (the extent to which a marginal increase in the *attention* $z^i_n$ allocated to the source reduces the idiosyncratic interpretation of its content). One can think of $z^i_n$ as the "time" or "effort" allocated to interpreting source $n$.

**Actions and Payoffs.** Let $k^i \in \mathbb{R}$ denote agent $i$'s action, $K \equiv \int k^j \mathrm{d}j$ the mean action in the population, and $\sigma_k^2 \equiv \int (k^j - K)^2 \mathrm{d}j$ the dispersion of individual actions around the population mean action.[6] Each agent's payoff is given by the (expectation of the) Bernoulli utility function

$$u\left(k^i, K, \sigma_k, \theta\right) - C(z^i),$$

where $C(z^i)$ denotes the attention cost incurred by the agent. The function $u$ is a general second-order polynomial satisfying the following conditions:[7]: (i) $u_{kk} < 0$, (ii) $u_{kK}/|u_{kk}| < 1$, (iii) $u_{kk} + 2u_{kK} + u_{KK} < 0$, (iv) $u_{kk} + u_{\sigma\sigma} < 0$, (v) $u_{k\theta} \neq 0$, and (vi) $u_{k\sigma} = u_{K\sigma} = u_{\theta\sigma} = u_\sigma(k, K, 0, \theta) = 0$. Condition (i) imposes concavity at the individual level, so that best responses are well defined. Condition (ii) implies that the slope of best responses is less than one, which in turn guarantees uniqueness of the equilibrium actions, for any given allocation of attention. Conditions (iii) and (iv) guarantee that the first-best allocation is unique and bounded. Condition (v) ensures that the fundamental $\theta$ affects equilibrium behavior, thus making the analysis non-trivial. Finally, Condition (vi) means that $u$ is additively separable in $\sigma_k^2$ with coefficient $u_{\sigma\sigma}/2$, which guarantees linearity of the agents' best responses and simplifies the analysis.

An example of a payoff function $u$ satisfying the above conditions is

$$u\left(k^i, K, \sigma_k, \theta\right) = -\frac{\alpha}{2}\left(k^i - K\right)^2 - \frac{1-\alpha}{2}\left(k^i - \theta\right)^2 + \frac{u_{\sigma\sigma}}{2}\sigma_k^2, \tag{1}$$

with $\alpha, u_{\sigma\sigma} \in \mathbb{R}_+$ and such that $\alpha, u_{\sigma\sigma} < 1$. Note that, under this specification, $u_{kk} = -1$, $u_{kK} = \alpha = -u_{KK}$, and $u_{k\theta} = 1 - \alpha$. Conditions (i)-(vi) are then equivalent to the restriction $\alpha, u_{\sigma\sigma} < 1$. Under this specification, one can think of $k^i$ as agent $i$'s investment in a new risky activity. The term $\alpha(k^i - K)^2/2$ captures the benefit ($\alpha > 0$) or cost ($\alpha < 0$) of aligning the investment with the average investment by other agents, whereas the term $(1-\alpha)(k^i - \theta)^2/2$ captures the benefit of aligning the investment with the underlying fundamental variable. Finally, the term $u_{\sigma\sigma}\sigma_k^2/2$ captures externalities from the dispersion of individual actions around the mean action. When $u_{\sigma\sigma} > 0$ these externalities are positive, whereas, when $\upsilon_{\sigma\sigma} < 0$, these externalities are negative. The game of Myatt and Wallace (2012) in which the acquisition and usage of information are efficient corresponds to a function $u$ of the type in (1) in which $u_{\sigma\sigma} = 0$; the beauty contest game of Morris and Shin (2002) in which agents are excessively concerned with aligning their actions with the actions of others correspond to a function $u$ of the type in (1) with $u_{\sigma\sigma} = \alpha > 0$. The payoff specification in (1), while convenient for equilibrium analysis, is not flexible enough for normative analysis. This is because of the following two properties: (a) the unique equilibrium actions when $\theta$ is common knowledge coincide with the first-best actions (and are equal to $\theta$), implying that there are no inefficiencies under complete information; the only externalities are from the dispersion of individual actions around the average action (when $u_{\sigma\sigma} = 0$, the equilibrium use of information is efficient when $u$ is of the form in (1)). Many economies considered in the literature do not satisfy these properties, i.e., exhibit inefficiencies also under complete information, and/or feature externalities that do not originate in the dispersion of individual actions. This is why it is important to accommodate for more general payoffs $u$ when doing normative analysis. The family of quadratic payoffs above has the advantage of capturing a rich set of payoff interdependencies that are responsive for inefficiencies in the acquisition and/or usage of information, while retaining tractability thanks to the linearity of the best responses (in applications in which the payoffs are not quadratic, it is customary to linearize the best responses around the full-information benchmark—here I prefer to assume that payoffs are quadratic so that the linearization is not necessary).

Next, consider the function $C$ describing the cost of attention. To facilitate the exposition, I assume throughout the main text that $C$ is linear, that is, there exists $\bar{c} \in \mathbb{R}_{++}$ such that, for any $z^i \in \mathbb{R}_+^N$,

$$C(z^i) = \bar{c} \cdot \textstyle\sum_{s=1}^N z^i_s. \tag{2}$$

Many results in the Appendix, however, are established for an arbitrary increasing, convex, and continuously differentiable function.[8]

[6] The reason why individual actions are denoted by $k^i$ instead of $a^i$ is to facilitate the comparison with the previous literature. In this literature, actions are often investment decisions and there is a tradition to denote the latter with $k^i$.

[7] The notation $u_k$ is used to denote the partial derivative of the $u$ function with respect to the $k$ argument. The notation $u_{kK}$ is used to denote the cross derivative with respect to $k$ and $K$. Similar notation applies to the other arguments.

[8] The assumption that $C$ is convex need not be compatible with an entropy-based cost function (that is, a cost function increasing in the mutual information between the random vectors $\tilde{y} \equiv (\tilde{y}_n)_{n=1}^N$ and $\tilde{x}^i \equiv (\tilde{x}^i_n)_{n=1}^N$), as in certain models of rational inattention. With that type of cost function, equilibrium uniqueness cannot be guaranteed for sufficiently high degrees of coordination. However, even in that case, social welfare continues to be concave in the allocation of attention, meaning that the efficient allocation of attention remains unique. Besides, all key results pertaining to (a) the comparison between the equilibrium allocation of attention and the efficient allocation of attention and (b) the comparison of the equilibrium with perfect recall and the one with bounded recall are established by looking at the *gross* private benefit of increasing the attention allocated to any given source. Because of this, all key results extend to a situation in which the attention cost is concave, even if in the latter case equilibrium uniqueness cannot be guaranteed.

**Timing**. Agents simultaneously choose the attention they allocate to the various sources of information. Each agent $i$ then observes privately the signals $x^i$. Finally, agents simultaneously commit their actions $k^i$, and payoffs are realized.

## 3. Perfect recall

In this section, I consider the benchmark of perfect recall, where agents remember the influence of individual sources on their posterior beliefs and respond differently to different sources. Subsection 3.1 characterizes the equilibrium allocation of attention and the subsequent usage of information. Subsection 3.2, instead, characterizes the efficient allocation of attention and the efficient usage of information.

### 3.1. Equilibrium

First note that, when $\theta$ is common knowledge, the unique equilibrium features each agent taking the action $k^i = \kappa(\theta)$, where

$$\kappa(\theta) \equiv \kappa_0 + \kappa_1 \theta,$$

with the scalars $\kappa_0 \in \mathbb{R}$ and $\kappa_1 \in \mathbb{R}$ given by $\kappa_0 \equiv -u_k(0,0,0,0)/(u_{kk}+u_{kK})$ and $\kappa_1 \equiv -u_{k\theta}/(u_{kk}+u_{kK})$, respectively. Hereafter, I refer to $\kappa$ as the complete-information equilibrium actions, dropping the dependence on the fundamental variable $\theta$ when not needed. I then denote by $\tilde{\kappa}$ the random variable corresponding to $\kappa$. As anticipated above, when payoffs take the form in (1), as, e.g., in Morris and Shin (2002), and Myatt and Wallace (2012), $\kappa_0 = 0$ and $\kappa_1 = 1$, in which case the complete-information actions are $\kappa(\theta) = \theta$.

Next, consider the problem of each agent $i$ under asymmetric information about $\theta$. Suppose agent $i$ allocates attention $z^i \in \mathbb{R}^N_+$ to the various sources of information and observes the signals $x^i \in \mathbb{R}^N$. Let

$$\alpha \equiv \frac{u_{kK}}{|u_{kk}|}$$

parametrize the importance the agent assigns to aligning (alternatively, differentiating) his action with the actions of others. Optimality requires that the agent's action satisfies

$$k^i = \mathbb{E}[(1-\alpha)\tilde{\kappa} + \alpha \tilde{K} \mid z^i, x^i]. \tag{3}$$

Next, consider the agent's choice of attention. Suppose that all agents allocate attention $z \in \mathbb{R}^N_+$ to the various sources of information. The (endogenous) *precision* of each source $s = 1, ..., N$ is then given by

$$\pi_s(z) \equiv \frac{\eta_s z_s t_s}{z_s t_s + \eta_s},$$

and is increasing in the source's accuracy $\eta_s$, its transparency $t_s$, and the attention $z_s$ allocated to the source. Denote by

$$\varphi^i_s \equiv \varepsilon_s + \xi^i_s$$

the total noise in the signal agent $i$ receives from source $s$, and note that $var(\tilde{\varphi}^i_s) = \pi_s(z)^{-1}$. Let

$$\rho_s(z) \equiv corr(\tilde{\varphi}^i_s, \tilde{\varphi}^j_s) = \frac{z_s t_s}{z_s t_s + \eta_s}$$

denote the correlation in the noise among any two different agents $i, j \in [0,1]$, $i \neq j$. Following Myatt and Wallace (2012), I refer to $\rho_s$ as the source's *endogenous publicity*.

For any $z \in \mathbb{R}^N_+$, any $n = 1, ..., N$, let

$$\gamma_n(z) \equiv \frac{\frac{(1-\alpha)\pi_n(z)}{1-\alpha\rho_n(z)}}{\pi_\theta + \sum_{s=1}^N \frac{(1-\alpha)\pi_s(z)}{1-\alpha\rho_s(z)}}. \tag{4}$$

Let $\mathrm{k}(\cdot; z) : \mathbb{R}^N \to \mathbb{R}$ be the function defined, for all $x^i \in \mathbb{R}^N$, by

$$\mathrm{k}(x^i; z) = \kappa_0 + \kappa_1 \sum_{n=1}^N \gamma_n(z) x^i_n. \tag{5}$$

The following result is then true:

**Proposition 1.** *There exists a unique symmetric equilibrium. In this equilibrium, the attention $\hat{z} \equiv (\hat{z}_n)_{n=1}^N$ that each agent $i \in [0,1]$ allocates to the various sources of information is such that, for any source $n = 1, ..., N$ that receives strictly positive attention (that is, for which $\hat{z}_n > 0$),*

$$\bar{c} = \frac{|u_{kk}|\kappa_1^2(\gamma_n(\hat{z}))^2}{2\left(\hat{z}_n\right)^2 t_n}, \tag{6}$$

*whereas, for any source that receives no attention*

$$\bar{c} \geq \frac{|u_{kk}|\kappa_1^2(1-\alpha)^2 t_n}{2\left[\pi_\theta + \sum_{s=1}^N \frac{(1-\alpha)\eta_s \hat{z}_s t_s}{(1-\alpha)\hat{z}_s t_s + \eta_s}\right]^2} = \lim_{z_n \to 0^+} \frac{|u_{kk}|\kappa_1^2(\gamma_n(\hat{z}_{-n}, z_n))^2}{2\left(z_n\right)^2 t_n}, \tag{7}$$

*where* $\hat{z}_{-n} \equiv (\hat{z}_1, ..., \hat{z}_{n-1}, \hat{z}_{n+1}, ..., \hat{z}_N)$. *Given the equilibrium allocation of attention* $\hat{z}$, *for any* $x^i$, *the action agent* $i$ *takes in equilibrium when the signals he receives are* $x^i$ *is* $k^i = \mathrm{k}(x^i; \hat{z})$, *any* $i \in [0,1]$.

To understand the result, consider the problem of an arbitrary agent $j \in [0,1]$. When the agent chooses attention $z^j$, all other agents $i \neq j$ choose attention $z$, and all agents (including $j$) choose actions according to the rule $\mathrm{k}(\cdot; z)$ in (5), the dispersion of agent $j$'s individual action $k^j$ around the mean action $K$ is given by

$$Var[\tilde{k}^j - \tilde{K} \mid z^j,\ z] = \kappa_1^2 \sum_{s=1}^N \frac{\gamma_s^2(z)}{z_s^j t_s},$$

where $\kappa_1 \gamma_s(z)$ is the influence of each source $s$ on the agents' actions. Differentiating $Var[\tilde{k}^j - \tilde{K} \mid z^j,\ z]$ with respect to $z_n^j$ while keeping the rule $\mathrm{k}(\cdot; z)$ fixed for all agents, including agent $j$, then reveals that

$$\left| \frac{\partial}{\partial z_n^j} Var[\tilde{k}^j - \tilde{K} \mid z^j,\ z] \right| = \frac{\kappa_1^2(\gamma_n(z))^2}{\left(z_n^j\right)^2 t_n}. \tag{8}$$

In equilibrium, $z^j = \hat{z}$. The marginal benefit that agent $j$ assigns to paying more attention to any source $n$, starting from $z^j = \hat{z}$, thus coincides with the marginal reduction of the dispersion of the agent's own action around the mean action in the population, weighted by the importance $|u_{kk}|/2$ that the individual assigns to such a reduction. This follows from an envelope argument: the agent expects the information to be used optimally when collected (i.e., according to the rule $\mathrm{k}(\cdot; \hat{z})$). Holding the rule $\mathrm{k}(\cdot; \hat{z})$ fixed, the only effect of a change in $z^j$ on the agent's expected payoff is through the effect that $z^j$ has on the dispersion of the agent's action around the mean action. It follows that the right-hand side of (6) is the marginal benefit of varying $z_n^j$ at $z^j = \hat{z}$. Whenever $\hat{z}_n > 0$, the marginal benefit must coincide with the marginal cost, which explains Condition (6). When, instead, $\hat{z}_n = 0$, the marginal cost must exceed the marginal benefit, which explains (7). As I show below, this interpretation also helps understanding the sources of inefficiency in the equilibrium allocation of attention.

Next note that the influence $\kappa_1 \gamma_n(\hat{z})$ that each source $n$ exerts on the equilibrium actions (as per (5)) increases with the source's endogenous precision $\pi_n$ and increases with the source's endogenous publicity $\rho_n$ when agents value positively aligning their actions with the actions of others (i.e., when $\alpha > 0$), whereas it decreases when they value such an alignment negatively (i.e., when $\alpha < 0$). In turn, both the precision $\pi_n$ and the publicity $\rho_n$ of any given source increase with the source's accuracy $\eta_n$ and with its transparency $t_n$. Finally, note that, when $\alpha \to 0$, the sensitivity of the equilibrium actions to each source of information converges to $\kappa_1 \delta_n(\hat{z})$ with

$$\delta_n(z) \equiv \frac{\pi_n(z)}{\pi_\theta + \sum_{s=1}^N \pi_s(z)}.$$

This limit corresponds to a single decision-maker's problem, in which the relative influence of any two sources of information is given by their relative informativeness, as captured by the ratio between the two sources' precisions. In contrast, when $\alpha \to 1$, $\gamma_n(\hat{z}) \to 0$ for all $n = 1, ..., N$: as the agents' concern for aligning their actions with the actions of others grows large, they ignore all sources of information and base their actions on the common prior.

The following is then also true:

**Corollary 1.** *There exists a threshold* $\bar{t} > 0$ *such that, in the unique symmetric equilibrium, for any source that receives strictly positive attention*

$$t_n \geq \bar{t},$$

*whereas for any source that receives no attention* $t_n \leq \bar{t}$.

As I show in the Appendix, the result extends to a non-linear cost of information $C$. For any $z \in \mathbb{R}_+^N$ and any $n = 1, ..., N$, let

$$C_n'(z) \equiv \partial C(z)/\partial z_n$$

denote the partial derivative of $C$ with respect to the attention allocated to the $n$-th source, evaluated at $z$. The general result is that there exists a threshold $\bar{r} > 0$ for the relative transparency of the sources such that any source that receives attention in equilibrium is such that

$$r_n(\hat{z}) \equiv \frac{t_n}{C_n'(\hat{z})} > \bar{r},$$

whereas any source that receives no attention is such that $r_n(\hat{z}) \leq \bar{r}$.[9] When a source's transparency is low relative to the marginal cost of expanding the attention to the source, paying attention to the source is not worth the cost, given that the reduction in the idiosyncratic interpretation of the source's content is small. The source thus does not receive any attention in equilibrium. When the attention cost depends only on total attention (which is the case under the linear specification in (2)), it is only the most transparent sources that receive attention in equilibrium. The attention that these sources receive, however, need not be monotone in their transparency. This is so even when the marginal cost of attention is the same across all the sources. This is because, when transparency is high, a small amount of attention suffices to almost completely eliminate any idiosyncratic interpretation of a source's content; as a result, attention can be maximal for intermediate degrees of transparency. The following example illustrates:

**Example 1.** Suppose that $\bar{c}$ is sufficiently small that all sources receive strictly positive attention in equilibrium. The attention that each source receives is then given by

$$\hat{z}_n = \frac{\eta_n}{\sqrt{t_n}(1-\alpha)}\left[\frac{(1-\alpha)\kappa_1\sqrt{\frac{|u_{kk}|}{2\bar{c}}} + \sum_{s=1}^N \frac{\eta_s}{\sqrt{t_s}}}{\pi_\theta + \sum_{s=1}^N \eta_s} - \frac{1}{\sqrt{t_n}}\right]. \tag{9}$$

The example illustrates the general properties discussed above that attention is increasing in accuracy, but possibly non-monotone in transparency. It also shows that, under the assumed cost functional, as the value of coordination $\alpha$ increases, the attention allocated to sources of low transparency decreases, whereas the attention allocated to sources of high transparency increases. Formally, $\partial \hat{z}_n/\partial\alpha < 0$ if

$$\sqrt{t_n} < \frac{\pi_\theta + \sum_{s=1}^N \eta_s}{\sum_{s=1}^N \frac{\eta_s}{\sqrt{t_s}}},$$

whereas $\partial \hat{z}_n/\partial\alpha > 0$ if the previous inequality is reversed. Finally, in this example, total attention decreases with the coordination motive, $\alpha$. This is not immediate to see, but can be verified by differentiating $\hat{Z} \equiv \sum_{s=1}^N \hat{z}_s$ with respect to $\alpha$ and using the property that

$$\left(\sum_{s=1}^N \frac{\eta_s}{\sqrt{t_s}}\right)^2 \leq \sum_{s=1}^N \frac{\eta_s}{t_s}\sum_{s=1}^N \eta_s.$$

### 3.2. Efficiency

Having characterized how agents allocate attention to the different sources and use the information they receive from them in equilibrium, I now turn to the allocation of attention and the usage of information that maximize the ex-ante utility of a representative agent. The analysis permits me to identify channels (i.e., payoff interdependencies) that are responsible for the inefficiency in the equilibrium allocation of attention and in the usage of information. These results, when applied to specific applications, may guide policy interventions aimed at increasing the efficiency of market interactions (see, for example, Colombo et al. (2025) for how governments can subsidize technology adoption when firms' information is endogenous).

First, observe that, when the fundamental variable is common knowledge, efficiency requires that all agents take the action

$$\kappa^*(\theta) = \kappa_0^* + \kappa_1^*\theta$$

where the scalars $\kappa_0^* \in \mathbb{R}$ and $\kappa_1^* \in \mathbb{R}$ are given by $\kappa_0^* = -\left(u_k(0,0,0) + u_K(0,0,0)\right)/\left(u_{kk} + 2u_{kK} + u_{KK}\right)$ and $\kappa_1^* = -\left(u_{k\theta} + u_{K\theta}\right)/\left(u_{kk} + 2u_{kK} + u_{KK}\right)$, respectively. Hereafter, I refer to $\kappa^*$ as the first-best-allocation, dropping the dependence on the fundamental variable $\theta$ when not needed. I then denote by $\tilde{\kappa}^*$ the random variable corresponding to $\kappa^*$.

Next, assume that all agents assign attention $z$ to the sources. Then, under asymmetric information, efficiency in the agents' actions requires that all agents follow the rule $\mathrm{k}^*(\cdot; z)$ to determine their actions, where the rule $\mathrm{k}^*(\cdot; z)$ is the unique solution to the functional equation

$$\mathrm{k}^*\left(x^i; z\right) = \mathbb{E}\left[\left(1-\alpha^*\right)\tilde{\kappa}^* + \alpha^*\tilde{K}^* \;\middle|\; z, x^i\right] \text{ for all } x^i \in \mathbb{R}^N, \tag{10}$$

where

$$\alpha^* \equiv \frac{u_{\sigma\sigma} - 2u_{kK} - u_{KK}}{u_{kk} + u_{\sigma\sigma}} \tag{11}$$

is the socially optimal degree of coordination (that is, the level of complementarity, or substitutability, that the planner would like the agents to perceive for the equilibrium of the economy to coincide with the efficient allocation), and where, for any $(\theta, \varepsilon)$,

[9] When $C$ takes the linear form in (2), $C_n'(\hat{z}) = \bar{c}$ for all $n$, in which case the above property implies the result in the corollary, with $\bar{t} = \bar{r}\bar{c}$.

$K^* = \mathbb{E}\left[\mathrm{k}^*\left(\tilde{x}^i; z\right) \mid z, \theta, \varepsilon\right]$ is the average action in the population when each agent's action is given by $k^i = \mathrm{k}^*\left(x^i; z\right)$, all $i \in [0,1]$, all $x^i \in \mathbb{R}^N$.[10] Note that Condition (10) differs from the equilibrium optimality condition (3) only by the fact that $\alpha$ is replaced by $\alpha^*$ and $\kappa$ by $\kappa^*$. It is then immediate that, given $z$, efficiency in the agents' actions requires that, for any $i \in [0,1]$ any $x^i \in \mathbb{R}^N$, $k^i = \mathrm{k}^*(x^i; z)$, where $\mathrm{k}^*(\cdot; z)$ is the function given by

$$\mathrm{k}^*(x^i; z) = \kappa_0^* + \kappa_1^* \sum_{n=1}^N \gamma_n^*(z) x_n^i, \tag{12}$$

where

$$\gamma_n^*(z) \equiv \frac{\frac{(1-\alpha^*)\pi_n(z)}{1-\alpha^*\rho_n(z)}}{\pi_\theta + \sum_{s=1}^N \frac{(1-\alpha^*)\pi_s(z)}{1-\alpha^*\rho_s(z)}}$$

has the same structure as $\gamma_n(z)$ in (4), but with $\alpha^*$ replacing $\alpha$.

I now turn to the efficient allocation of attention. Note that, for any attention $z$, welfare when all agents follow the efficient rule $\mathrm{k}^*(\cdot; z)$ can be expressed as

$$w^*(z) \equiv \mathbb{E}[u(\tilde{\kappa}^*, \tilde{\kappa}^*, 0, \tilde{\theta})] - \mathcal{L}^*(z) - \bar{c},$$

where $\mathbb{E}[u(\tilde{\kappa}^*, \tilde{\kappa}^*, 0, \tilde{\theta})]$ is expected welfare under the first-best allocation, whereas

$$\mathcal{L}^*(z) \equiv \frac{|u_{kk} + 2u_{kK} + u_{KK}|}{2} Var[\tilde{K} - \tilde{\kappa}^* \mid z] + \frac{|u_{kk} + u_{\sigma\sigma}|}{2} Var[\tilde{k}^i - \tilde{K} \mid z]$$

combines the welfare losses originating in the volatility of the average action $K$ around its first-best counterpart $\kappa^*$ with the losses originating in the dispersion of each agent $i$'s individual action around the mean action. Using the envelope theorem (that is, accounting for the fact that information is used efficiently when collected) and observing that, when all actions are taken according to the rule $\mathrm{k}^*(\cdot; z)$, the volatility $Var[\tilde{K} - \tilde{\kappa}^* \mid z]$ of the aggregate action $K$ around the first-best allocation $\kappa^*$ is independent of the allocation of attention, I have that the *social benefit* of increasing the attention allocated to any source $n$ (gross of its cost) is given by[11]

$$\frac{|u_{kk} + u_{\sigma\sigma}|}{2} \left| \frac{\partial}{\partial z_n} Var[\tilde{k}^j - \tilde{K} \mid z] \right| = \frac{|u_{kk} + u_{\sigma\sigma}|}{2} \frac{\left(\kappa_1^* \gamma_n^*(z)\right)^2}{\left(\hat{z}_n\right)^2 t_n}, \tag{13}$$

where $\partial Var[\tilde{k}^j - \tilde{K} \mid z]/\partial z_n$ is computed fixing the strategy $\mathrm{k}^*(\cdot; z)$ that maps the individual signals into the individual actions. In other words, when information is used efficiently, the social benefit of increasing the attention to any given source is given by the reduction in the dispersion of individual actions around the mean action that obtains when agents allocate more attention to that source, weighted by the social aversion to dispersion $|u_{kk} + u_{\sigma\sigma}|/2$. The following result then follows from the arguments above:

**Proposition 2.** *Suppose the agents use the information efficiently. There exists a unique allocation of attention $z^*$ that maximizes welfare. For any source $n$ that receives strictly positive attention,*

$$\bar{c} = \frac{|u_{kk} + u_{\sigma\sigma}|}{2} \frac{(\kappa_1^*)^2 \left(\gamma_n^*(z^*)\right)^2}{\left(z_n^*\right)^2 t_n},$$

*whereas for any source that receives no attention,*

$$\bar{c} \geq \frac{|u_{kk} + u_{\sigma\sigma}|}{2} \frac{(\kappa_1^*)^2 (1-\alpha^*)^2 t_n}{\left[\pi_\theta + \sum_{s=1}^N \frac{(1-\alpha^*)\eta_s z_s t_s}{(1-\alpha^*) z_s t_s + \eta_s}\right]^2} = \lim_{z_n \to 0^+} \frac{|u_{kk} + u_{\sigma\sigma}|}{2} \frac{(\kappa_1^*)^2 (\gamma_n^*(z_{-n}^*, z_n))^2}{\left(z_n\right)^2 t_n},$$

*where $\kappa_1^* \gamma_n^*(z^*)$ is the influence of the source on the agents' actions under the efficient rule $\mathrm{k}^*(\cdot; z^*)$.*

Comparing the private benefit (8) of expanding the attention to a source to the social benefit (13) then permits me to establish the following conclusion:

[10] The characterization of the efficient use of information for given $z$ follows from steps similar to those in Angeletos and Pavan (2009). The contribution here is in the characterization of the efficient allocation of attention.

[11] As in the equilibrium case, the expression in (13) applies to sources that receive strictly positive attention (that is, for which $z_n > 0$). The marginal benefit of increasing the attention allocated to a source that receives zero attention is simply the limit of the right-hand side of (13) as $z_n \to 0^+$ which is equal to

$$\frac{|u_{kk} + u_{\sigma\sigma}|}{2} \frac{(\kappa_1^*)^2 (1-\alpha^*)^2 t_n}{\left[\pi_\theta + \sum_{s=1}^N \frac{(1-\alpha^*)\eta_s z_s t_s}{(1-\alpha^*) z_s t_s + \eta_s}\right]^2}.$$

**Corollary 2.** *Let $\hat{z}$ denote the equilibrium allocation of attention. Starting from $\hat{z}$, asking the agents to pay more attention to a source that receives strictly positive attention in equilibrium (i.e., for which $\hat{z}_n > 0$) and then use the received information efficiently (i.e., according to the rule $\mathrm{k}^*(\cdot;\hat{z})$) increases welfare if*

$$|u_{kk}|(\kappa_1\gamma_n(\hat{z}))^2 < |u_{kk}+u_{\sigma\sigma}|(\kappa_1^*\gamma_n^*(\hat{z}))^2, \tag{14}$$

*and decreases it if the inequality in (14) is reversed, where $\kappa_1\gamma_n(\hat{z})$ and $\kappa_1^*\gamma_n^*(\hat{z})$ are the sensitivities of the agents' actions to the n-th source of information, under the equilibrium and the efficient rules $\mathrm{k}(\cdot;\hat{z})$ and $\mathrm{k}^*(\cdot;\hat{z})$, respectively. Likewise, having the agents pay attention to a source $n$ that receives no attention in equilibrium (i.e., for which $\hat{z}_n = 0$) increases welfare if*

$$\frac{|u_{kk}+u_{\sigma\sigma}|}{2}\frac{(\kappa_1^*)^2(1-\alpha^*)^2 t_n}{\left[\pi_\theta+\sum_{s=1}^N \frac{(1-\alpha^*)\eta_s\hat{z}_s t_s}{(1-\alpha^*)\hat{z}_s t_s+\eta_s}\right]^2} > \bar{c},$$

*and decreases it if the inequality is reversed.*

To understand the result, recall from the analysis above that both the private and the social (gross) marginal benefit of allocating more attention to any given source come from the marginal reduction in the dispersion of individual actions around the mean action.[12] The magnitude of this reduction depends on the source's influence on the agents' actions, which is given by $\kappa_1\gamma_n(\hat{z})$ under the equilibrium rule $\mathrm{k}(\cdot;\hat{z})$, and by $\kappa_1^*\gamma_n^*(\hat{z})$ under the efficient rule $\mathrm{k}^*(\cdot;\hat{z})$. The weight that the planner assigns to reducing the dispersion of individual actions is $|u_{kk}+u_{\sigma\sigma}|$, whereas the weight that each individual agent assigns to reducing the dispersion of his action around the mean action is $|u_{kk}|$, with the discrepancy between the two weights naturally reflecting externalities from the dispersion of individual actions. Starting from the equilibrium allocation of attention $\hat{z}$, asking the agents to increase the attention they allocate to any source that receives strictly positive attention in equilibrium and then use the received information efficiently then increases welfare if and only if the marginal reduction in the dispersion of actions under the equilibrium rule $\mathrm{k}(\cdot;\hat{z})$, weighted by the importance $|u_{kk}|$ that each agent assigns to dispersion, falls short of the marginal reduction in dispersion under the efficient rule $\mathrm{k}^*(\cdot;\hat{z})$, weighted by the importance $|u_{kk}+u_{\sigma\sigma}|$ that the planner assigns to dispersion.

Likewise, for any source that receives no attention in equilibrium, the marginal cost exceeds the private marginal benefit of reducing dispersion. Starting from the equilibrium allocation of attention $\hat{z}$, asking the agents to pay attention to any such source increases welfare if and only if the marginal cost falls short of the social marginal benefit of reducing dispersion. Put differently, efficiency in the allocation of attention requires both (i) efficiency in the subsequent use of information and (ii) alignment between the private and the social value of reducing the dispersion of individual actions around the mean actions, which obtains when, and only when, there are no externalities from the dispersion of individual actions around the mean action, i.e., $u_{\sigma\sigma} = 0$.

To appreciate the implications of Corollary 2, it is useful to focus on a few benchmark cases. First, consider economies in which the usage of information is efficient, i.e., the equilibrium rule $\mathrm{k}(\cdot;\hat{z})$ coincides with the efficient rule $\mathrm{k}^*(\cdot;\hat{z})$. Note that these are economies in which the complete-information equilibrium actions are first-best efficient (i.e., $\kappa = \kappa^*$) and the equilibrium degree of coordination coincides with the socially optimal one (i.e., $\alpha = \alpha^*$). When agents suffer from the dispersion of individual actions, i.e., when $u_{\sigma\sigma} < 0$, starting from the equilibrium allocation of attention, a higher welfare can be attained by having the agents pay more attention to any source that receives strictly positive attention in equilibrium. When, instead, the agents benefit from the dispersion of individual actions, i.e., when $u_{\sigma\sigma} > 0$, a higher welfare can be attained by asking the agents to reduce the attention they pay to any source that receives strictly positive attention in equilibrium. This is because, holding the rule $\mathrm{k}^*(\cdot;\hat{z})$ fixed, an increase (alternatively, a decrease) in attention contributes to a reduction (alternatively, an increase) in the dispersion of individual actions around the mean action.

Next, consider economies in which the inefficiency in the allocation of attention is due to the sensitivity $\kappa_1$ of the complete-information equilibrium actions to the fundamentals (i.e., $\alpha = \alpha^*$, $u_{\sigma\sigma} = 0$, but $\kappa_1 \neq \kappa_1^*$). When $|\kappa_1| < |\kappa_1^*|$, under complete information, in equilibrium, agents respond too little to the fundamentals relative to what is efficient. A higher welfare can then be attained by asking the agents to pay more attention to all sources that receive strictly positive attention in equilibrium and then use the received information efficiently according to the rule $\mathrm{k}^*(\cdot;\hat{z})$. The opposite conclusion holds when $|\kappa_1| > |\kappa_1^*|$, that is, when, under complete information, agents over-respond to the fundamentals. This is because, in the former case (i.e., when $|\kappa_1| < |\kappa_1^*|$), the reduction in dispersion is larger when the agents use the information efficiently (i.e., according to the rule $\mathrm{k}^*(\cdot;\hat{z})$) than when they use it according to the equilibrium rule $\mathrm{k}(\cdot;\hat{z})$. The opposite is true when $|\kappa_1| > |\kappa_1^*|$. In this latter case, the planner would like the agents to respond less to the information they receive. As a result, the planner would also like the agents to reduce the attention they assign to the sources.

Lastly, consider economies in which the inefficiency in the allocation of attention is due to the discrepancy $\alpha - \alpha^*$ between the equilibrium and the socially optimal degrees of coordination. I then have the following result:

**Proposition 3.** *Consider economies in which (a) the sensitivity of the complete-information equilibrium actions to the fundamentals is first-best efficient ($\kappa_1 = \kappa_1^*$), (b) there are no externalities from dispersion ($u_{\sigma\sigma} = 0$), and (c) inefficiencies in the use of information originate in the discrepancy between the equilibrium and the socially optimal degrees of coordination ($\alpha \neq \alpha^*$). Let $\hat{z}$ be the equilibrium allocation of*

[12] By usual envelope arguments, both marginal reductions are computed holding fixed the equilibrium and efficient rules $\mathrm{k}(\cdot;\hat{z})$ and $\mathrm{k}^*(\cdot;\hat{z})$, respectively.

*attention. There exists a threshold $t^* > 0$ such that, when $\alpha > \alpha^*$, starting from $\hat{z}$, having the agents pay more attention to a source $n$ that receives strictly positive attention in equilibrium (i.e., for which $\hat{z}_n > 0$) and then use the received information efficiently increases welfare if $t_n < t^*$, whereas it reduces it if $t_n > t^*$. The opposite conclusions hold for $\alpha < \alpha^*$. Furthermore, the equilibrium total attention is inefficiently low and too few sources receive positive attention if $\alpha > \alpha^*$, whereas the opposite conclusions hold if $\alpha < \alpha^*$.*

Hence, when agents over-value aligning their actions with the actions of others (i.e., when $\alpha > \alpha^*$), starting from the equilibrium allocation of attention $\hat{z}$, higher welfare can be obtained by having the agents pay more attention to sources of low transparency and less attention to sources of high transparency. In the Appendix, I show that the result extends to non-linear attention costs (namely, I show that there exists a threshold $r^*$ such that the planner would like the agents to increase the attention to sources for which $\hat{z}_n > 0$ and $r_n(\hat{z}) \equiv t_n / C_n'(\hat{z}) < r^*$ and reduce the attention to sources for which $\hat{z}_n > 0$ and $r_n(\hat{z}) > r^*$). In other words, economies in which agents are over-concerned with aligning their actions with the actions of others are economies in which, in equilibrium, agents pay too much attention to sources whose transparency is high relative to their cost, and too little attention to sources whose transparency is low relative to their cost. This is because highly transparent sources are good coordination devices. The opposite conclusions hold in economies in which agents under-value aligning their actions with the actions of others, i.e., for which $\alpha < \alpha^*$.

In the Appendix I also show that, when the attention cost $C$ depends only on total attention (as is the case under the linear structure in (2)), too few sources receive strictly positive attention in equilibrium and the total attention $\hat{Z} \equiv \sum_{s=1}^N \hat{z}_s$ allocated to the various sources in equilibrium is inefficiently low when agents over-value aligning their actions with the actions of others (i.e., when $\alpha > \alpha^*$), whereas the opposite conclusions hold when agents under-value aligning their actions with the actions of others (i.e., $\alpha < \alpha^*$).

As an illustration, consider an economy satisfying the properties of Example 1 above, and in which all sources receive strictly positive attention in equilibrium. It is easy to see that, as long as the difference $|\alpha - \alpha^*|$ between the equilibrium and the efficient degrees of coordination is small, the planner also wants the agents to allocate attention to all sources. The efficient allocation of attention then satisfies the analog of the conditions in (9) with $\alpha^*$ replacing $\alpha$. When $\alpha > \alpha^*$, that is, when agents over-value aligning their actions, any source for which

$$t_n < \left( \frac{\pi_\theta + \sum_{s=1}^N \eta_s}{\sum_{s=1}^N \left( \eta_s / \sqrt{t_s} \right)} \right)^2,$$

receives too little attention in equilibrium, whereas any source for which the above inequality is reversed receives too much attention in equilibrium.

Results qualitatively similar to those discussed above obtain in economies in which, for any $z$, the planner expects the agents to take their actions according to the equilibrium rule $\mathrm{k}(\cdot; z)$ of Proposition 1 instead of the efficient rule $\mathrm{k}^*(\cdot; z)$ of Proposition 2. In these economies, the social benefit of changing the agents' attention to the sources also accounts for the effect that such a change has on the subsequent usage of information, i.e., the mapping from the agents' signals $x^j$ to the agents' actions $k^j$ (see the Online Supplement). In concrete micro-founded applications, these results have direct implications for the design of policies that, by manipulating the equilibrium actions (for examples through taxes and subsidies on individual activity) also manipulate the collection of information.

## 4. Bounded recall

The results in the previous section are for economies in which, at the time of committing their actions, the agents recall the information they received from individual sources. Equivalently, the agents summarize all the information received into a statistic that permits them to play the same action as when they remember the content of individual sources (which is the case when the statistic is the equilibrium action itself). I now turn to the (perhaps more plausible) case of bounded recall in which the agents anticipate a difficulty in keeping track of the content of individual sources and do not trust that what they will recall will permit them to play the same actions as when they perfectly recall.

Given the attention $z^j \equiv (z_n^j)_{n=1}^N$ assigned to the different sources and the information $x^j \equiv (x_n^j)_{n=1}^N$ received from them, the statistic that agent $j$ recalls is given by

$$X^j \equiv \sum_{n=1}^N \lambda_n(z^j) x_n^j, \tag{15}$$

where, for any $n = 1, ..., N$,

$$\lambda_n(z^j) \equiv \frac{\pi_n(z^j)}{\sum_{s=1}^N \pi_s(z^j)}, \tag{16}$$

is the precision of source $n$ relative to the total precision

$$\pi_X(z^j) \equiv \sum_{s=1}^N \pi_s(z^j) \tag{17}$$

of the sources. The statistic $X^j$ thus summarizes all the information about the exogenous fundamentals $\theta$ contained in the individual signals $x^j$, given the attention $z^j$ to the sources. Note that the statistic

$$X^j = \theta + \sum_{n=1}^N \lambda_n(z^j) \varphi_n^i$$

is itself a signal about the fundamental variable $\theta$ with (endogenous) precision $\pi_X(z^j)$, where, for any $n = 1, ..., N$, $\varphi_n^i \equiv \varepsilon_n + \xi_n^i$ is source $n$'s total noise. Furthermore, when any two agents $i, j \in [0,1]$, $j \neq i$, allocate the same attention $z^i = z^j = z$ to the sources, the correlation in the error in the statistics $X^i$ and $X^j$ across the two agents is given by

$$\begin{aligned}\rho_X(z) &\equiv Corr\left(\sum_{n=1}^N \lambda_n(z)\tilde{\varphi}_n^i; \sum_{n=1}^N \lambda_n(z)\tilde{\varphi}_n^j\right)\\ &= \sum_{n=1}^N \lambda_n(z)\rho_n(z),\end{aligned} \tag{18}$$

where, for any $n = 1, ..., N$,

$$\rho_n(z) \equiv Corr(\tilde{\varphi}_n^i, \tilde{\varphi}_n^j) = \frac{z_n t_n}{z_n t_n + \eta_n}$$

continues to denote the (endogenous) correlation in the error contained in source $n$, across the two individuals, as in the benchmark with perfect recall. In other words, $\rho_X(z)$ is a weighted average of the publicity of the individual sources, with each weight $\lambda_n(z)$ given by the precision of the source, relative to the total precision of the individual signals (equivalently, the precision $\pi_X(z^j)$ of the statistic $X^j$).

The specification above thus also captures the possibility that, in certain environments, there are no source-specific signals and, instead, given the attention $z^j$ allocated to the information sources, the agent receives a single signal $X^j$ about $\theta$ with endogenous precision $\pi_X(z^j)$ and whose error has correlation $\rho_X(z^j)$ with the error of any other agent allocating the same attention to the sources.

In the Appendix, I consider more general (linear) statistics of the signals that range from the one described above to the optimal actions in the benchmark of full recall. These general statistics reflect the idea that, in many situations of interest, the information the agents recall is tilted away from the equilibrium action towards the Bayesian projection of the fundamentals $\theta$ on the information received. The tilt may be small and may originate in the fact that the information collected is used also for decision problems other than the one under consideration. Importantly, the agents do not choose what to recall — the functions $\lambda(\cdot)$ are exogenous. If they could choose, they would simply recall the optimal actions, in which case the results would be identical to those for perfect recall.

Apart from the change described above, the environment is the same as in the previous section.

### 4.1. Equilibrium allocation of attention

Mathematically, bounded recall amounts to the restriction that each agent's actions be measurable in the sigma algebra generated by the random variable $\tilde{X}^j$. The equilibrium under bounded recall is thus a specific *analogy-based equilibrium* (as defined in Jehiel, 2005) with the coarsening of the partitions of the agents' information sets generated by grouping together information sets corresponding to the same value of the statistic $\tilde{X}^j$.

For any $z \in \mathbb{R}_+^N$, let $\mathrm{k}^{\#}(\cdot; z)$ be the function defined, for all $X^i \in \mathbb{R}$, by

$$\mathrm{k}^{\#}(X^i; z) = \kappa_0 + \kappa_1 \gamma^{\#}(z) X^i, \tag{19}$$

with

$$\gamma^{\#}(z) \equiv \frac{\frac{(1-\alpha)\pi_X(z)}{1-\alpha\rho_X(z)}}{\pi_\theta + \frac{(1-\alpha)\pi_X(z)}{1-\alpha\rho_X(z)}}. \tag{20}$$

**Proposition 4.** *Suppose that, given any allocation of attention $z^j$, and any realization $x^j = (x_n^j)_{n=1}^N$ of the individual signals, what each agent $j$ recalls of $x^j$ is summarized in the statistic $X^j$ given by (15). There is a unique symmetric equilibrium. In this equilibrium, the attention allocated to the various sources of information is $z^{\#}$ and individual actions are given by $k^i = \mathrm{k}^{\#}(X^i; z^{\#})$, all $i \in [0,1]$, all $X^i \in \mathbb{R}$. Furthermore, for any source $n = 1, ..., N$ that receives strictly positive attention in equilibrium,*

$$\bar{c} = -\frac{|u_{kk}|}{2}\frac{\partial}{\partial z_n} Var\left[\tilde{k}^j - \tilde{K}; z^{\#}\right] - \frac{|u_{kk}|}{2}(1-\alpha)\frac{\partial}{\partial z_n} Var\left[\tilde{K} - \tilde{\kappa}; z^{\#}\right], \tag{21}$$

*whereas any source that receives no attention is such that*

$$\bar{c} \geq -\frac{|u_{kk}|}{2}\frac{\partial}{\partial z_n} Var\left[\tilde{k}^j - \tilde{K}; z^{\#}\right] - \frac{|u_{kk}|}{2}(1-\alpha)\frac{\partial}{\partial z_n} Var\left[\tilde{K} - \tilde{\kappa}; z^{\#}\right], \tag{22}$$

*where all the derivatives are computed holding fixed the rule $\mathrm{k}^{\#}(\cdot; z^{\#})$ given by (19).*

There are important differences relative to the case of perfect recall. First, the marginal benefit of increasing the attention to each source now has two components. The first one (formally captured by the first term in (21)) is the marginal reduction of the dispersion of the agent's action around the mean action in the population. This component is similar to the one under perfect recall. Importantly, in a symmetric equilibrium, the reduction is the same irrespective of whether one changes only the individual's attention or all agents'

attention (this observation, which is formally proved in the proof of Proposition 4 in the Appendix, is important when comparing the equilibrium with the efficient allocation of attention).[13]

The second component (formally captured by the second term in (21)) is new and reflects the fact that, with bounded recall, a change in attention also affects the dispersion of the agent's own average action

$$K^j \equiv \mathbb{E}[\mathrm{k}^{\#}(\tilde{X}^j; z^{\#})|\theta, \varepsilon] = \kappa_0 + \kappa_1 \gamma^{\#}(z^{\#}) \left(\theta + \sum\nolimits_{n=1}^{N} \lambda_n(z^{\#})\varepsilon_n\right)$$

around its complete-information counterpart. The reason is that a change in attention changes the weights $\lambda_n(z)$ in the statistic $\tilde{X}^j$ and hence affects not only the volatility of the statistic $\tilde{X}^j$ but also its mean given the aggregate variables $(\theta, \varepsilon)$. The second term in the right-hand side of (21) represents the marginal benefit of bringing an agent's own average action, which in a symmetric equilibrium coincides with the average action $K$ in the population, closer to the complete-information equilibrium action, $\kappa$. Importantly, while the weight the individual assigns to reducing the dispersion of his own action around the mean action in the population continues to be given by the curvature of the individual payoffs, $u_{kk}$, the weight the individual assigns to reducing the volatility of his average action around the complete-information counterpart is given by $|u_{kk}|(1-\alpha) = -(u_{kk} + u_{kK})$, and accounts also for the response of the agent's action to variations in the average action in the population.

The following result is then also true:

**Proposition 5.** *Suppose that, given the allocation of attention $z^j$, what each agent $j$ recalls of the individual signals $x^j$ is summarized in the statistic $X^j$ given by (15). Starting from any allocation of attention $z$ that is symmetric across the agents, there exist thresholds $\rho', \rho''$ with $0 \leq \rho' \leq \rho'' \leq 1$ such that the following is true: relative to the case of perfect recall, the benefit of locally increasing the attention allocated to source $n$ is (weakly) larger if $\rho_n(z) \in [\rho', \rho'']$ and (weakly) smaller if $\rho_n(z) \notin [\rho', \rho'']$. Furthermore, when $\alpha$ is large, $0 < \rho' < \rho'' < 1$.*

Observe that the endogenous publicity of any source $n$ is given by

$$\rho_n(z) = \frac{\pi_n(z)}{\eta_n} = \frac{z_n t_n}{z_n t_n + \eta_n}.$$

As explained above, the latter measures how the total error $\tilde{\varphi}_n^j = \tilde{\varepsilon}_n + \tilde{\xi}_n^j$ in the source (combining the error at the origin, $\tilde{\varepsilon}_n$, with the error $\tilde{\xi}_n^j$ in the agent's idiosyncratic interpretation of the source's content) correlates across any two agents. Sources of low publicity are sources whose endogenous precision $\pi_n(z)$ is small relative to the source's exogenous accuracy, $\eta_n$. A low precision in turn may be due either to a low transparency $t_n$ of the source or little attention $z_n$ allocated to it. In either case, the information received from such a source is subject to significant idiosyncratic noise in the agent's interpretation of the source's content. Relative to the case of perfect recall, the benefit of increasing the attention to such a source is smaller under bounded recall because of the impossibility for the agent's action to respond to the source's noise $\tilde{\varphi}_n^j$ separately from how it responds to other sources. Sources of high publicity, instead, are sources of potentially low accuracy but of high transparency or that receive significant attention. These sources serve primarily as coordination devices. With bounded recall, however, the coordination value of these sources is dampened because of the impossibility of responding separately to the noise associated with their interpretation. As a result, the benefit of expanding the attention to such sources is again smaller than under perfect recall. Finally, consider sources of intermediate publicity. These are good "compromises", in that they permit the agent to align his action well both with the fundamentals and with the other agents' actions. The benefit of expanding the attention to such sources under bounded recall is thus higher than under perfect recall.

In the case in which the attention cost depends only on total attention, as assumed in (2), the monotone relationship between the publicity of the sources in the benchmark of perfect recall and their exogenous transparency further permits me to establish the following result:

**Corollary 3.** *Let $\hat{z}$ be the allocation of attention in the unique symmetric equilibrium under perfect recall. There exist thresholds $t', t'' \in \mathbb{R}_+$ such that, starting from $\hat{z}$, any agent with bounded recall can (weakly) increases his payoff by (a) locally increasing the attention to any source for which $\hat{z}_n > 0$ and $t_n \in [t', t'']$ and (b) locally decreasing the attention to any source for which $\hat{z}_n > 0$ and $t_n \notin [t', t'']$.*

The results in Proposition 5 and Corollary 3 refer to local properties of best responses, evaluated around the equilibrium allocation of attention $\hat{z}$ in the benchmark with perfect recall. Similar conclusions hold when one compares the allocation of attention in the unique symmetric *equilibrium* with bounded recall to its counterpart under perfect recall.

**Proposition 6.** *Let $\hat{z}$ be the allocation of attention in the unique symmetric equilibrium with perfect recall and $z^{\#}$ the corresponding allocation of attention under bounded recall. There exist thresholds $t', t'' \in \mathbb{R}_{++}$ such that $z_n^{\#} > \hat{z}_n$ only if $t_n \in [t', t'']$. Furthermore for any source $n$ for which $t_n \in [t', t'']$, $z_n^{\#} < \hat{z}_n$ only if $z_n^{\#} = 0$.*

[13] This property is also true in the benchmark with bounded recall. There, however, the result is obvious, given that the distribution of the average action $\tilde{K}$ is independent of the allocation of attention. In contrast, with bounded recall, the distribution of the average action depends on the allocation of attention, even when one holds fixed the mapping $\mathrm{k}^{\#}(\cdot; z)$. The reason is that the allocation of attention impacts the weights $\lambda(z)$ assigned by the summary statistic to the various sources of information.

The result in Proposition 6 thus establishes that it is only those sources whose transparency is intermediate that receive more attention under bounded recall than under perfect recall. In this sense, Proposition 6 extends the results in Proposition 5 and Corollary 3 from individual best responses to equilibrium choices. The key property in the Appendix that permits me to establish the result in the proposition is that, among those sources that do receive some attention under bounded recall, those whose transparency is the highest are also those whose publicity is the highest. Recall that this property also holds under perfect recall. In that benchmark, the monotonicity extends to all sources, implying that it is only those sources whose transparency is high enough that receive some attention in equilibrium. I could not establish this stronger property under bounded recall. In other words, I could not exclude the possibility that source $n$ with transparency $t_n$ receives some attention whereas source $n'$ with transparency $t_{n'} > t_n$ does not. This explains why the result in the proposition is not an "if and only if" result. However, what I could establish is that if a source of intermediate transparency receives less attention under bounded recall, then it receives no attention at all.

### 4.2. Efficient allocation of attention

I conclude by investigating the allocation of attention that maximizes welfare under bounded recall. The analysis is motivated by the interest in establishing whether, at least at a qualitative level, the inefficiencies identified above for perfect recall remain valid under bounded recall.

Consistently with the analysis above, I assume that the planner cannot choose the functions $\lambda$ defining the weights in the statistic $\tilde{X}^j$, but can control the agents' attention and their response to the realizations $X^j$ of the statistic $\tilde{X}^j$ (clearly, if the planner could choose the weights $\lambda$, the efficient allocation of attention would be the same as under perfect recall).

First note that, because the planner's problem is concave, it is never optimal to induce different agents to allocate different attention to the various sources of information. This in turn means that, for any symmetric allocation of attention $z$, efficiency of the agents' actions requires that, for any agent $j \in [0,1]$, almost any value $X^j$ of the statistic $\tilde{X}^j$, the agent's action be given by $k^j = \mathrm{k}^{**}(X^j; z)$, where, for any $z \in \mathbb{R}^N_+$, the function $\mathrm{k}^{**}(\cdot; z)$ is defined by

$$\mathrm{k}^{**}(X^j; z) = \kappa_0^* + \kappa_1^* \gamma^{**}(z) X^j \tag{23}$$

all $X^j \in \mathbb{R}$ with

$$\gamma^{**}(z) \equiv \frac{\frac{(1-\alpha^*)\pi_X(z)}{1-\alpha^*\rho_X(z)}}{\pi_\theta + \frac{(1-\alpha^*)\pi_X(z)}{1-\alpha^*\rho_X(z)}}, \tag{24}$$

where $\pi_X(z)$ and $\rho_X(z)$ are as in (17) and (18) above.[14] This implies that, for any allocation of attention $z$, the maximum welfare that can be achieved by having the agents follow the rule $\mathrm{k}^{**}(\cdot; z)$ defined by (23) is given by

$$w^*(z) \equiv \mathbb{E}[u(\tilde{\kappa}^*, \tilde{\kappa}^*, 0, \tilde{\theta})] - \mathcal{L}^*(z) - C(z), \tag{25}$$

where, for any realization $\theta$ of the fundamental variable $\tilde{\theta}$, $u(\kappa^*, \kappa^*, 0, \theta)$ continues to denote welfare when each agent's action $k^j$ coincides with the first-best action $\kappa^*(\theta) = \kappa_0^* + \kappa_1^* \theta$, and where

$$\mathcal{L}^*(z) \equiv \frac{|u_{kk} + u_{\sigma\sigma}|}{2} Var[\tilde{k}^j - \tilde{K} \mid z] + \frac{|u_{kk} + 2u_{kK} + u_{KK}|}{2} Var[\tilde{K} - \tilde{\kappa}^* \mid z]$$

continues to denote the welfare losses due to the asymmetry of information (combining the losses from the dispersion of individual actions around the mean action with the losses stemming from the volatility of the average action around its first-best counterpart). Using the fact that $|u_{kk} + 2u_{kK} + u_{KK}| = (1-\alpha^*)|u_{kk} + u_{\sigma\sigma}|$ and denoting by $z^{**}$ the efficient allocation of attention under bounded recall, I then have that any source of information that receives strictly positive attention must satisfy

$$\begin{aligned} \bar{c} = &-\frac{|u_{kk} + u_{\sigma\sigma}|}{2} \frac{\partial}{\partial z_n} Var[\tilde{k}^j - \tilde{K} \mid z^{**}] \\ &- \left(1-\alpha^*\right) \frac{|u_{kk} + u_{\sigma\sigma}|}{2} \frac{\partial}{\partial z_n} Var[\tilde{K} - \tilde{\kappa}^* \mid z^{**}], \end{aligned} \tag{26}$$

where all derivatives are computed holding fixed the rule $\mathrm{k}^{**}(\cdot; z^{**})$.

Comparing the social to the private benefit of increasing the attention to any source around the equilibrium levels then permits me to establish the following results.

**Proposition 7.** *Let $z^\#$ denote the allocation of attention in the unique symmetric equilibrium with bounded recall.*

*(a) Consider economies that are efficient in their use of information ($\kappa = \kappa^*$ and $\alpha = \alpha^*$). Starting from the equilibrium allocation of attention $z^\#$, having the agents pay more attention to a source that receives strictly positive attention in equilibrium (i.e., for which $z_n^\# > 0$) increases welfare if $u_{\sigma\sigma} < 0$ and decreases it if $u_{\sigma\sigma} > 0$.*

[14] The result follows from the observation that bounded recall is mathematically equivalent to a setting in which agents observe a single signal $\tilde{X}^j$ about $\theta$ with precision $\pi_X(z)$ and whose noise has correlation $\rho_X(z)$ across any two agents.

*(b) Consider economies in which there are no externalities from dispersion ($u_{\sigma\sigma} = 0$), and the equilibrium and the socially optimal degrees of coordination coincide ($\alpha = \alpha^*$). Starting from the equilibrium allocation of attention $z^\#$, having the agents pay more attention to a source that receives strictly positive attention in equilibrium (i.e., for which $z^\#_n > 0$) and then use the information efficiently according to the rule $\mathrm{k}^{**}(\cdot; z^\#)$ increases welfare if $\kappa_1 < \kappa_1^*$ and decreases it if $\kappa_1 > \kappa_1^*$.*

Hence, in economies in which the equilibrium and the socially optimal degrees of coordination coincide ($\alpha = \alpha^*$), the inefficiencies in the allocation of attention parallel those under perfect recall.

Next, consider economies in which the inefficiencies in the allocation of attention and in the subsequent utilization of information originate in the discrepancy between the equilibrium and the socially optimal degrees of coordination ($\alpha \neq \alpha^*$).

**Proposition 8.** *Let $z^\#$ denote the allocation of attention in the unique symmetric equilibrium with bounded recall. Consider economies in which the sensitivity of the complete-information equilibrium actions to the fundamentals is first-best efficient (i.e., $\kappa_1 = \kappa_1^*$) and in which there are no externalities from the dispersion of individual actions (i.e., $u_{\sigma\sigma} = 0$). When*

$$\alpha(\gamma^\#(z^\#))^2 > \alpha^*(\gamma^{**}(z^\#))^2$$

*there exists a critical threshold $\bar\rho(z^\#) \in [0,1]$ such that, starting from the equilibrium allocation of attention $z^\#$, having the agents reduce the attention to sources of high endogenous publicity (namely, for which $\rho_n(z^\#) > \bar\rho(z^\#)$) and increase the attention to sources of low endogenous publicity (for which $\rho_n(z^\#) < \bar\rho(z^\#)$ and $z^\#_n > 0$), and then use the received information efficiently (i.e., according to the rule $\mathrm{k}^{**}(\cdot; z^\#)$) increases welfare. The opposite conclusions hold for economies in which $\alpha(\gamma^\#(z^\#))^2 < \alpha^*(\gamma^{**}(z^\#))^2$. In the limit in which $\pi_\theta \to 0$, $\bar\rho(z^\#) \to \rho_X(z^\#)$ and $\gamma^\#(z^\#), \gamma^{**}(z^\#) \to 1$, implying that higher welfare can be obtained by having the agents pay less attention to sources for which $(\alpha - \alpha^*)\left[\rho_n(z^\#) - \rho_X(z^\#)\right] > 0$ and more attention to sources for which the last inequality is reversed and $z^\#_n > 0$.*

Formally, the results in Proposition 8 are different from those under perfect recall. However, the spirit is similar: When agents over-value aligning their actions with the actions of others, the planner would like the agents to reduce the attention to sources of high endogenous publicity and increase the attention to sources of low endogenous publicity; the opposite conclusions hold when agents under-value aligning their actions with the actions of others.

## 5. Other related literature

As indicated in the Introduction, the paper belongs to the recent literature on attention and information acquisition in coordination environments. For an analysis of general properties of monotone equilibria in Bayesian games of strategic complementarity, see the earlier work by Van Zandt and Vives (2007) and the more recent work by Amir and Lazzati (2016).

Banerjee et al. (2022) consider a coordination model with motivated beliefs in which the payoff structure is the same as in the present paper but in which the agents choose how to interpret the precision of their private information. The motivation is similar to the one in the literature on aspirational utility: in choosing how to interpret the various sources, agents trade off the ability to align their actions with the fundamentals and the actions of others with the possibility to derive a higher aspirational utility by believing the precision of their information to be higher than the actual one.

Linear-quadratic-Gaussian models have also been used in the network literature (see, among others, Calvo-Armengol et al. (2015), and Galeotti et al. (2020)), as well as in the organization-economics literature (see, among others, Alonso et al. (2008), and Dessein et al. (2016)). Lambert et al. (2018) provide general equilibrium existence and uniqueness results for linear-quadratic games with flexible information structures.

Related are also Hebert and La'O (2023) and Angeletos and Sastry (2025). The first paper considers a coordination setting in which payoffs are as in the beauty contest of Myatt and Wallace (2012). The analysis identifies key properties of the cost of information responsible for non-fundamental volatility and inefficiency in the usage of information. The former property obtains when learning from public signals (which contain noise at the source) is cheaper than learning the fundamentals directly (the paper identifies the condition of the cost functional that is responsible for such a cost saving and shows that it is violated under entropy reduction). The second property obtains when the agents' attention affects other agents' ability to learn. In the absence of such a learning externality, because welfare is the potential of the game, information is collected and used efficiently. Angeletos and Sastry (2025), instead, study the validity of the welfare theorems in economies with rationally-inattentive agents. The key finding is that these theorems hold provided that there are no learning externalities. Because markets are complete in Angeletos and Sastry (2025), the inefficiencies in the collection and usage of information discussed in the present paper do not arise in the economies considered in that paper.

Pavan et al. (2025) study optimal policy interventions in economies in which markets are incomplete and agents acquire private information and then submit price-contingent schedules (equivalently, limit orders). Angeletos and La'O (2020) study monetary policy in economies with endogenous dispersed information. Colombo et al. (2025), instead, study optimal subsidies in economies with endogenous private information and investment spillovers.

Hellwig and Veldkamp (2009) are the first to study the relation between the complementarity/substitutability in actions and the complementarity/substitutability in information acquisition. The information structure in that paper is different from the one in the present paper in that it assumes that the publicity of each source is exogenous and that the attention allocated to each source is binary. This last property can favor equilibrium indeterminacy. In contrast, the (symmetric) equilibrium is unique in the present paper, as well as in most of the papers cited above.

Chahrour (2014) studies optimal central bank disclosures in an economy in which processing information is costly and in which agents may mis-coordinate on which sources they pay attention to. Herskovic and Ramos (2020) study coordination and information acquisition in a model of network formation in which agents learn from peers. Llosa and Venkateswaran (2022) compare the equilibrium acquisition of private information to its efficient counterpart in three different specifications of the business cycle.

The works mentioned above consider economies with continuous payoffs. Information acquisition in games of regime change (where payoffs are discontinuous) is studied in Szkup and Trevino (2015), Yang (2015), and Morris and Yang (2022). The first paper considers a canonical information structure with a single perfectly private additive signal whose precision is determined in equilibrium. The second paper considers a flexible information structure with an entropy cost and shows how the possibility to learn asymmetrically across states (which is appealing in discontinuous games) may lead to equilibrium indeterminacy. The third paper, instead, shows how equilibrium (in)determinacy relates to the possibility of distinguishing nearby states at a finite cost. Contrary to the present paper, these works assume that the signals the agents receive are independent, conditional on the underlying fundamental. This assumption is relaxed in Denti (2023); that paper shows, among other things, how the endogenous correlation in the noise in the agents' signals may contribute to equilibrium uniqueness.

As anticipated above, the present paper is also related (but only in spirit) to the literature on rational inattention. See, e.g., Sims (2003, 2011) for an earlier overview of this literature, Maćkowiak and Wiederholt (2009) for an influential business-cycle application, Matějka and McKay (2012, 2015) for how rational inattention provides a foundation for the multinomial logit model, Hébert and Woodford (2023), and Steiner et al. (2017) for extensions to dynamic problems, and Maćkowiak et al. (2023) for an overview of the more recent literature. Among these papers, the closest is Maćkowiak and Wiederholt (2012). That paper compares the equilibrium allocation of attention to its efficient counterpart, assuming that the decision-makers can absorb any information as long as the reduction in entropy is below a given threshold. Contrary to what assumed in this literature, in the present paper, the agents learn from an exogenous (but arbitrarily large) set of sources. This assumption permits me to investigate which dimension (transparency versus accuracy) receives more weight in equilibrium, and whether the equilibrium weights are socially inefficient. Importantly, as explained above, modeling explicitly the information sources permits me to study the effects of bounded recall.

The paper is also related to the literature investigating the effects of bounded memory on individual decision making (see, e.g., Mullainathan (2002), Benabou and Tirole (2004), Wilson (2014), and Kocer (2010)). This literature does not investigate how bounded memory influences the allocation of attention in a strategic setting, or the discrepancy between the equilibrium and the efficient allocation of attention. The effects of bounded recall in settings with strategic interactions are, instead, examined in the literature on dynamic (and repeated) games with imperfect information (see, e.g., Mailath and Samuelson (2006) and the references therein). The formalization of bounded recall, as well as the questions addressed in that literature, is, however, very different from the ones in the present paper.

Finally, the paper is related to the literature that investigates how boundedly rational agents may group together different information sets into analogy-based equivalence classes when computing best responses, as pioneered by Jehiel (2005)—see also Jehiel and Samet (2007), Jehiel and Koessler (2008), and Jehiel and Samuelson (2012). In the present paper, the coarsening of the information sets is the one corresponding to the equivalence classes defined by the agents' summary statistics of the individual signals, with the latter coinciding with the Bayesian projection when the agents recall only their posterior beliefs about the exogenous fundamentals.

## 6. Conclusions

I compare the equilibrium to the efficient allocation of attention in a framework featuring a rich class of payoff interdependencies and an arbitrary large number of information sources differing in their accuracy and transparency. I then examine how the allocation of attention is affected by bounded recall, namely by the difficulty of keeping track of the influence of individual sources on posterior beliefs and by the expectation that what will be recalled is tilted away from the optimal action towards a Bayesian summary statistic of the information received.

In future work, it would be interesting to extend the analysis to dynamic settings in which agents solve a stopping problem by choosing, in each period, whether to collect further information from additional sources or irreversibly commit to an action. It would also be interesting to examine how the allocation of attention interacts with the market provision of information by endogenizing the supply of information. Such an extension would also permit one to investigate policy interventions aimed at correcting the interaction between the inefficiencies in the usage and in the provision of information.

## Declaration of competing interest

I declare that I have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix

Throughout the Appendix, many of the results are established for a general increasing, convex, differentiable cost function $C : \mathbb{R}_+^N \to \mathbb{R}$. For any $z \equiv (z_s)_{s=1}^N \in \mathbb{R}_+^N$ and any $n = 1, ..., N$, I then denote by

$$C_n'(z) \equiv \partial C(z)/\partial z_n$$

the partial derivative of $C$ with respect to the $n$-th dimension, evaluated at $z$.

**Proof of Proposition 1.** Suppose that all agents allocate attention $\hat{z}$ to the various sources of information. In the continuation game in which each agent $i$ observes the realization $x^i$ of the random vector $\tilde{x}^i$ and chooses his action $k^i$ optimally, there is a unique Bayes-Nash equilibrium and is such that each agent $i$, for any $x^i$, selects the action $k^i = \mathrm{k}(x^i;\hat{z})$, where, for any $z \in \mathbb{R}^N_+$ and $x^i \in \mathbb{R}^N$, $\mathrm{k}(x^i;z)$ is as defined in (5). This result follows from arguments similar to those that lead to Proposition 3 in Angeletos and Pavan (2009) — the proof is thus omitted.

Next, consider the acquisition of information. Let

$$U^j(z^j;\hat{z}) = \mathbb{E}[u(\tilde{k}^j,\tilde{K},\tilde{\sigma}_k,\tilde{\theta})|z^j] - C(z^j)$$

denote the payoff expected by any agent $j \in [0,1]$ who allocates attention $z^j$ to the various sources and then chooses his actions $k^j$ optimally, when all agents $i \neq j$ pay attention $\hat{z}$ to the different sources and then choose their actions according to (5) with $z = \hat{z}$. It is easy to show that $U^j(z^j;\hat{z})$ is continuously right-differentiable in $z^j_n$, any $n = 1,...,N$, any $(z^j;\hat{z})$, and that, for any $z^j_n > 0$, the derivative $\partial U^j(z^j;\hat{z})/\partial z^j_n$ coincides with the partial derivative of the agent's expected payoff with respect to $z^j_n$ holding fixed (by usual envelope arguments) the rule $\mathrm{k}^j(\cdot;z^j,\hat{z}) : \mathbb{R}^N \to \mathbb{R}$ describing the agent's optimal action given the observed signals $x^j$, with $\mathrm{k}^j(\cdot;z^j,\hat{z})$ such that

$$\mathrm{k}^j(x^j;z^j,\hat{z}) \in \arg\max_{k^j} \mathbb{E}[u(k^j,\tilde{K},\tilde{\sigma}_k,\tilde{\theta})|z^j]$$

for all $x^j \in \mathbb{R}^N$.

Next, note that, when $z^j = \hat{z}$, by symmetry, the optimal rule $\mathrm{k}^j(\cdot;z^j,\hat{z})$ for the agent coincides with the one of any other agent, that is, for any $x^j$, $\mathrm{k}^j(x^j;\hat{z};\hat{z}) = \mathrm{k}(x^j;\hat{z})$. Furthermore, when all agents (including agent $j$) choose their actions according to the rule in (5), with $z = \hat{z}$, for any choice of $z^j$, agent $j$'s expected payoff is given by

$$\mathbb{E}[u(\tilde{K},\tilde{K},\sigma_k,\tilde{\theta}) \mid z^j;\hat{z}] + \frac{u_{kk}}{2} Var[\tilde{k}^j - \tilde{K} \mid z^j;\hat{z}] - C(z^j) \tag{27}$$

where the first term in the right-hand side of (27) is the payoff the agent obtains if his action coincides with the average action

$$K = \kappa_0 + \kappa_1 \textstyle\sum_{n=1}^N \gamma_n(\hat{z}) y_n = \kappa_0 + \kappa_1 \sum_{n=1}^N \gamma_n(\hat{z})(\theta + \varepsilon_n)$$

in the population in every state, whereas the second term is the ex-ante dispersion of the agent's own action

$$k^j = \kappa_0 + \kappa_1 \textstyle\sum_{n=1}^N \gamma_n(\hat{z}) x^j_n = \kappa_0 + \kappa_1 \sum_{n=1}^N \gamma_n(\hat{z})(\theta + \varepsilon_n + \xi^j_n)$$

around the mean action. Note that $\mathbb{E}[u(\tilde{K},\tilde{K},\tilde{\sigma}_k,\tilde{\theta}) \mid z^j;\hat{z}]$ is invariant in $z^j$. It follows that, in any symmetric equilibrium, for any source $n$ that receives positive attention, that is, for which $\hat{z}_n > 0$, the following optimality condition must hold:

$$\frac{\partial U^j(\hat{z};\hat{z})}{\partial z^j_n} = \frac{u_{kk}}{2} \frac{\partial}{\partial z^j_n} Var[\tilde{k}^j - \tilde{K} \mid z^j;\hat{z}] - C'_n(\hat{z}). \tag{28}$$

Note that the derivative in the right hand side of (28) is computed holding fixed the function $\mathrm{k}^j(\cdot;\hat{z},\hat{z})$ and letting such a function coincide with the one given in (5), with $z = \hat{z}$, i.e., for any $x^j$, $\mathrm{k}^j(x^j;\hat{z},\hat{z}) = \mathrm{k}(x^j;\hat{z})$.

Next observe that, when all agents (including $j$) follow the rule in (5), with $z = \hat{z}$,[15]

$$Var[\tilde{k}^j - \tilde{K} \mid z^j;\hat{z}] = \kappa_1^2 \sum_{n=1}^N \frac{(\gamma_n(\hat{z}))^2}{z^j_n t_n}.$$

I conclude that, in any symmetric equilibrium, for any source that receives strictly positive attention, the following optimality condition must hold

$$C'_n(\hat{z}) = \frac{|u_{kk}|}{2} \frac{(\kappa_1 \gamma_n(\hat{z}))^2}{\left(\hat{z}^j_n\right)^2 t_n}. \tag{29}$$

By continuity of the right-hand derivative $\partial U^j_+(z^j;\hat{z})/\partial z^j_n$, I also have that, for any source that receives no attention, the following corner condition must hold

$$C'_n(\hat{z}) \geq \lim_{z_n \to 0^+} \frac{|u_{kk}|\kappa_1^2(\gamma_n(\hat{z}_{-n},z_n))^2}{2\left(z_n\right)^2 t_n} = \frac{|u_{kk}|\kappa_1^2(1-\alpha)^2 t_n}{2\left[\pi_\theta + \sum_{s=1}^N \frac{(1-\alpha)\pi_s(\hat{z})}{1-\alpha\rho_s(\hat{z})}\right]^2} = \frac{|u_{kk}|\kappa_1^2(1-\alpha)^2 t_n}{2\left[\pi_\theta + \sum_{s=1}^N \frac{(1-\alpha)\eta_s \hat{z}_s t_s}{(1-\alpha)\hat{z}_s t_s + \eta_s}\right]^2},$$

which is equivalent to the condition that $\partial U^j_+(\hat{z};\hat{z})/\partial z^j_n \leq 0$.

[15] Note that, when $z^j_n = \hat{z}_n = 0$, $(\gamma_n(\hat{z}))^2/z^j_n t_n = 0$. The contribution of source $n$ to the dispersion of the agent's own action around the mean action can thus be written as $(\gamma_n(\hat{z}))^2/z^j_n t_n$ for any source, irrespective of whether or not such a source receives attention in equilibrium.

Lastly, to see that the symmetric equilibrium is unique, let $\mathcal{U}'$ denote the family of second-order polynomial payoff functions $u$ satisfying Conditions (i)-(vi) in Section 2. From arguments similar to those that lead to Proposition 2 in Angeletos and Pavan (2009), one can show that, given any $u \in \mathcal{U}'$, there exists a unique $u' \in \mathcal{U}'$ such that any symmetric equilibrium of the game where payoffs are given by $u$ coincides with one of the efficient allocations for the economy with payoffs given by $u'$. Next observe that the efficient allocation for the economy with payoffs given by $u'$ is unique – this follows from the fact that the planner's problem consisting in choosing a vector $z^i \in \mathbb{R}^N_+$ along with a function $\mathrm{k}^i : \mathbb{R}^N \to \mathbb{R}$ for each agent $i \in [0,1]$ so as to maximize the ex-ante expectation of $u'$ is strictly concave. This in turn implies that the symmetric equilibrium for the economy with payoffs given by $u$ is also unique. The result in the proposition follows from what established above after specializing the cost to the linear structure in (2). Q.E.D.

**Proof of Corollary 1.** As shown in the proof of Proposition 1, any source that receives strictly positive attention in equilibrium must satisfy Condition (29). Substituting for

$$\gamma_n(\hat{z}) = \frac{\frac{(1-\alpha)\hat{z}_n t_n \eta_n}{(1-\alpha)\hat{z}_n t_n + \eta_n}}{\pi_\theta + \sum_{s=1}^N \frac{(1-\alpha)\hat{z}_s t_s \eta_s}{(1-\alpha)\hat{z}_s t_s + \eta_s}}$$

into Condition (29), I then have that

$$\hat{z}_n = \frac{\eta_n}{\sqrt{t_n}(1-\alpha)} \left\{ (1-\alpha) \sqrt{\frac{|u_{kk}|\kappa_1^2}{2C_n'(\hat{z})}} \frac{1}{M_1(\hat{z})} - \frac{1}{\sqrt{t_n}} \right\}, \tag{30}$$

where, for any $z \in \mathbb{R}^N_+$,

$$M_1(z) \equiv \pi_\theta + \sum_{s=1}^N \frac{(1-\alpha)\eta_s z_s t_s}{(1-\alpha) z_s t_s + \eta_s} > 0. \tag{31}$$

For the right-hand-side in (30) to be positive, it must be that

$$r_n(\hat{z}) \equiv \frac{t_n}{C_n'(\hat{z})} \geq \frac{2\left(M_1(\hat{z})\right)^2}{(1-\alpha)^2 \kappa_1^2 |u_{kk}|} \equiv \bar{r}. \tag{32}$$

Next, I prove that, for any source that receives no attention in equilibrium, $r_n(\hat{z}) \leq \bar{r}$. To see this, suppose that, by contradiction, there exists a source $n$ for which $r_n(\hat{z}) > \bar{r}$ and such that $\hat{z}_n = 0$. Suppose that the individual were to increase locally the attention allocated to this source. The continuity of the right-hand derivative of the agent's expected payoff $U^j(\hat{z}; \hat{z})$, as defined in the proof of Proposition (1), implies that the net effect on the agent's expected payoff is

$$\frac{|u_{kk}|\kappa_1^2}{2} \frac{(1-\alpha)^2 t_n}{\left(M_1(\hat{z})\right)^2} - C_n'(\hat{z}) > 0,$$

contradicting the optimality of the equilibrium allocation of attention.

The result in the corollary follows from what established in this proof by specializing the cost to the linear structure in (2), and letting $\bar{t} \equiv \bar{r}\bar{c}$. Q.E.D.

**Proof of Example 1.** Assume that the cost of information takes the linear form in (2), and suppose that all sources receive strictly positive attention in equilibrium. The result in Proposition 1 then implies that the equilibrium attention to each source $n$ is equal to

$$\hat{z}_n = \sqrt{\frac{|u_{kk}|\kappa_1^2}{2\bar{c}}} \frac{\gamma_n(\hat{z})}{\sqrt{t_n}}. \tag{33}$$

It follows that

$$\gamma_n(\hat{z}) = \sqrt{\frac{2\bar{c}}{|u_{kk}|\kappa_1^2}} \sqrt{t_n} \hat{z}_n. \tag{34}$$

Combining the above with the fact that

$$\gamma_n(\hat{z}) = \frac{\frac{(1-\alpha)\pi_n(\hat{z})}{1-\alpha\rho_n(\hat{z})}}{\pi_\theta + \sum_{s=1}^N \frac{(1-\alpha)\pi_s(\hat{z})}{1-\alpha\rho_s(\hat{z})}}, \tag{35}$$

I then have that

$$\sum_{n=1}^{N}\gamma_n(\hat{z})=\frac{\sum_{s=1}^{N}\frac{(1-\alpha)\pi_s(\hat{z})}{1-\alpha\rho_s(\hat{z})}}{\pi_\theta+\sum_{s=1}^{N}\frac{(1-\alpha)\pi_s(\hat{z})}{1-\alpha\rho_s(\hat{z})}}=\sqrt{\frac{2\bar{c}}{|u_{kk}|\kappa_1^2}}\sum_{n=1}^{N}\sqrt{t_n}\hat{z}_n.$$

This implies that

$$\pi_\theta+\sum_{s=1}^{N}\frac{(1-\alpha)\pi_s(\hat{z})}{1-\alpha\rho_s(\hat{z})}=\frac{\pi_\theta}{1-\sqrt{\frac{2\bar{c}}{|u_{kk}|\kappa_1^2}}\sum_{s=1}^{N}\sqrt{t_s}\hat{z}_s}.$$

Replacing the latter expression into the definition of $\gamma_n(\hat{z})$ in (35) and using the fact that

$$\frac{(1-\alpha)\pi_n(\hat{z})}{1-\alpha\rho_n(\hat{z})}=\frac{(1-\alpha)\eta_n\hat{z}_nt_n}{\hat{z}_nt_n(1-\alpha)+\eta_n},$$

I then have that

$$\gamma_n(\hat{z})=\frac{\frac{(1-\alpha)\eta_n\hat{z}_nt_n}{\hat{z}_nt_n(1-\alpha)+\eta_n}}{\frac{\pi_\theta}{1-\sqrt{\frac{2\bar{c}}{|u_{kk}|\kappa_1^2}}\sum_{s=1}^{N}\sqrt{t_s}\hat{z}_s}}.$$

Combining this expression with (33), I then have that

$$\hat{z}_n=\left[\frac{1}{\pi_\theta\sqrt{\frac{2\bar{c}}{|u_{kk}|\kappa_1^2}}}-\frac{1}{\pi_\theta}\sum_{s=1}^{N}\sqrt{t_s}\hat{z}_s\right]\frac{1}{\sqrt{t_n}}\eta_n-\frac{\eta_n}{(1-\alpha)t_n}. \tag{36}$$

Multiplying both sides of (36) by $\sqrt{t_n}$, summing over $n$, and rearranging, I then obtain that

$$\frac{1}{\pi_\theta}\sum_{s=1}^{N}\sqrt{t_s}\hat{z}_s=\frac{\frac{\sum_{s=1}^{N}\eta_s}{\pi_\theta\sqrt{\frac{2\bar{c}}{|u_{kk}|\kappa_1^2}}}-\frac{1}{(1-\alpha)}\sum_{s=1}^{N}\frac{\eta_s}{\sqrt{t_s}}}{\pi_\theta+\sum_{s=1}^{N}\eta_s}. \tag{37}$$

Replacing (37) into (36), I conclude that

$$\hat{z}_n=\frac{\eta_n}{\sqrt{t_n}(1-\alpha)}\left[\frac{(1-\alpha)\sqrt{\frac{|u_{kk}|\kappa_1^2}{2\bar{c}}}+\sum_{s=1}^{N}\frac{\eta_s}{\sqrt{t_s}}}{\pi_\theta+\sum_{s=1}^{N}\eta_s}-\frac{1}{\sqrt{t_n}}\right] \tag{38}$$

as claimed. Q.E.D.

**Proof of Proposition 2.** The result follows from the same steps establishing Proposition 1 after replacing $\alpha$ with $\alpha^*$ and $\kappa$ with $\kappa^*$.

**Proof of Corollary 2.** The result follows from Proposition 2 along with the arguments in the main text.

**Proof of Proposition 3.** Let $\hat{z}$ denote the equilibrium allocation of attention and $z^*$ the efficient allocation of attention (i.e., the attention that maximizes welfare when the agents' actions are determined efficiently according to the rule k$^*$). Similarly, let $\#\hat{N}$ denote the number of sources that receive positive attention in equilibrium, and $\#N^*$ the number of sources that receive positive attention under the efficient allocation.

Note that, in the economies under consideration, for any $z$, and any $n$, the discrepancy between the social and the private benefit of increasing the attention allocated to source $n$ is proportional to the difference[16]

$$\frac{(\gamma_n^*(z))^2}{(z_n)^2t_n}-\frac{(\gamma_n(z))^2}{(z_n)^2t_n}. \tag{39}$$

Using the expressions for $\gamma$ and $\gamma^*$, the difference in (39) is equal to

$$m^*(z)\frac{t_n\eta_n^2}{\left[(1-\alpha^*)z_nt_n+\eta_n\right]^2}-m(z)\frac{t_n\eta_n^2}{\left[(1-\alpha)z_nt_n+\eta_n\right]^2}$$

[16] Note that the comparison applies also to sources that receive no attention, i.e., for which $z_n=0$; see footnote 15.

where

$$m(z) \equiv \frac{(1-\alpha)^2}{\left[\pi_\theta + \sum_{l=1}^N \frac{(1-\alpha)z_l t_l \eta_l}{(1-\alpha)z_l t_l + \eta_l}\right]^2} \text{ and } m^*(z) \equiv \frac{(1-\alpha^*)^2}{\left[\pi_\theta + \sum_{l=1}^N \frac{(1-\alpha^*)z_l t_l \eta_l}{(1-\alpha^*)z_l t_l + \eta_l}\right]^2}.$$

It follows that, starting from the equilibrium allocation of attention $\hat{z}$, the social benefit of increasing the attention allocated to source $n$ exceeds the private benefit if

$$\frac{(1-\alpha)\hat{z}_n t_n + \eta_n}{(1-\alpha^*)\hat{z}_n t_n + \eta_n} > \sqrt{\frac{m(\hat{z})}{m^*(\hat{z})}}, \tag{40}$$

whereas if falls short of the private benefit when the inequality in (40) is reversed.

Now note that, when $\alpha > \alpha^*$, $m(\hat{z}) < m^*(\hat{z})$, whereas, when $\alpha < \alpha^*$, $m(\hat{z}) > m^*(\hat{z})$. This means that, for any source that receives no attention in equilibrium (i.e., such that $\hat{z}_n = 0$), the social benefit exceeds the private benefit when $\alpha > \alpha^*$, whereas the opposite conclusion holds when $\alpha < \alpha^*$.

Next, consider sources that receive strictly positive attention in equilibrium. In the proof of Corollary 1, I establish that, for any such source,

$$\hat{z}_n = \frac{\eta_n}{\sqrt{t_n}(1-\alpha)}\left\{(1-\alpha)\sqrt{\frac{|u_{kk}|\kappa_1^2}{2C_n'(\hat{z})}}\frac{1}{M_1(\hat{z})} - \frac{1}{\sqrt{t_n}}\right\}, \tag{41}$$

where $M_1(z)$ is the same function defined in (31). It follows that

$$\hat{z}_n t_n = \frac{\eta_n \sqrt{t_n}}{\sqrt{C_n'(\hat{z})}} Q(\hat{z}) - \frac{\eta_n}{(1-\alpha)}, \tag{42}$$

where, for any $z \in \mathbb{R}_+^N$,

$$Q(z) \equiv \sqrt{\frac{|u_{kk}|\kappa_1^2}{2}}\frac{1}{M_1(z)}.$$

Using (42), I can rewrite the left-hand-side of (40) as follows

$$\frac{(1-\alpha)Q(\hat{z})\sqrt{\frac{t_n}{C_n'(\hat{z})}}}{(1-\alpha^*)Q(\hat{z})\sqrt{\frac{t_n}{C_n'(\hat{z})}} + \frac{\alpha^*-\alpha}{1-\alpha}}. \tag{43}$$

The expression in (43) is decreasing in $t_n/C_n'(\hat{z})$ for $\alpha > \alpha^*$ and increasing in $t_n/C_n'(\hat{z})$ for $\alpha < \alpha^*$. I conclude that, when $\alpha > \alpha^*$, there exists a critical value $r^* > 0$ such that, starting from the equilibrium allocation of attention $\hat{z}$, a higher welfare can be attained by having the agents increase the attention allocated to any source of information that receives positive attention in equilibrium and such that $r_n(\hat{z}) \equiv t_n/C_n'(\hat{z}) < r^*$ and decrease the attention to any source that receives positive attention and for which $r_n(\hat{z}) > r^*$. The opposite conclusions hold for $\alpha < \alpha^*$. The result in the proposition then obtains by specializing the results above to the linear attention cost in (2) and by letting $t^* = \bar{c}r^*$.

Lastly, suppose there exists an increasing, convex, and differentiable function $c : \mathbb{R}_+ \to \mathbb{R}_+$ such that, for any $z \in \mathbb{R}_+^N$, $C(z) = c\left(\sum_{s=1}^N z_s\right)$. Clearly, the linear cost in (2) is a special case. Note that, in these economies, the efficient allocation $(z^*, \mathrm{k}^*(\cdot; z^*))$ coincides with the equilibrium allocation of another economy that differs from the original one only in the degree of coordination. It thus suffices to show that the equilibrium total attention $\hat{Z} \equiv \sum_{s=1}^N \hat{z}_s$ as well as the number of sources $\#\hat{N}$ that receive strictly positive attention in equilibrium decrease with $\alpha$, where $\hat{N}$ denotes the subset of sources that receive strictly positive attention in equilibrium. The attention allocated in equilibrium to each source $n$ is given by

$$\hat{z}_n = \frac{\eta_n}{\sqrt{t_n}(1-\alpha)} \max\left\{\hat{T} - \frac{1}{\sqrt{t_n}}; 0\right\} \tag{44}$$

where

$$\hat{T} \equiv (1-\alpha)\sqrt{\frac{|u_{kk}|\kappa_1^2}{2c'(\hat{Z})}}\frac{1}{\hat{M}_1} \tag{45}$$

with

$$\hat{Z} \equiv \sum_{l=1}^N \hat{z}_l \tag{46}$$

and

$$\hat{M}_1 \equiv M_1(\hat{z}). \tag{47}$$

From (44)-(47), I then have that, for any $\alpha$, $\hat{T}$ is the unique solution to the following equation

$$\frac{T}{1-\alpha}\sqrt{c'\left(\sum_{l=1}^{N}\frac{\eta_l}{\sqrt{t_l}(1-\alpha)}\max\left\{T-\frac{1}{\sqrt{t_l}};0\right\}\right)}\left(\pi_\theta+\sum_{l=1}^{N}\frac{\eta_l\sqrt{t_l}\max\left\{T-\frac{1}{\sqrt{t_l}};0\right\}}{\sqrt{t_l}\max\left\{T-\frac{1}{\sqrt{t_l}};0\right\}+1}\right)=\kappa_1\sqrt{\frac{|u_{kk}|}{2}}. \tag{48}$$

Because the left-hand-side of (48) is increasing in both $\alpha$ and $T$, I then have that $\hat{T}$ is decreasing in $\alpha$. This means that the critical level of transparency required for each source to receive positive attention in equilibrium increases with $\alpha$. In turn, this implies that $\#\hat{N}$ decreases with $\alpha$, as claimed. To see that the total attention $\hat{Z}$ also decreases with $\alpha$, follow steps similar to those in the proof of Example 1 to see that, for each source that receives strictly positive attention in equilibrium (i.e., such that $n\in\hat{N}$),

$$\hat{z}_n=\frac{\eta_n}{\sqrt{t_n}(1-\alpha)}\left[\frac{(1-\alpha)\sqrt{\frac{|u_{kk}|\kappa_1^2}{2c'(\sum_{s\in\hat{N}}\hat{z}_s)}}+\sum_{s\in\hat{N}}\frac{\eta_s}{\sqrt{t_s}}}{\pi_\theta+\sum_{s\in\hat{N}}\eta_s}-\frac{1}{\sqrt{t_n}}\right].$$

Summing over all $n\in\hat{N}$, I then have that

$$\sum_{n\in\hat{N}}\hat{z}_n=\frac{1}{\sqrt{2c'\left(\sum_{s\in\hat{N}}\hat{z}_s\right)}}\left(\frac{\sqrt{|u_{kk}|\kappa_1^2}\sum_{n\in\hat{N}}\frac{\eta_n}{\sqrt{t_n}}}{\pi_\theta+\sum_{s\in\hat{N}}\eta_s}\right)+\frac{1}{1-\alpha}\left\{\frac{\left[\sum_{s\in\hat{N}}\frac{\eta_s}{\sqrt{t_s}}\right]^2}{\pi_\theta+\sum_{s\in\hat{N}}\eta_s}-\sum_{n\in\hat{N}}\frac{\eta_n}{t_n}\right\}.$$

Holding $\hat{N}$ fixed, I then have that

$$\frac{\partial}{\partial\alpha}\left(\sum_{s\in\hat{N}}\hat{z}_s\right)\overset{\text{sgn}}{=}\frac{\left[\sum_{s\in\hat{N}}\frac{\eta_s}{\sqrt{t_s}}\right]^2}{\pi_\theta+\sum_{s\in\hat{N}}\eta_s}-\sum_{n\in\hat{N}}\frac{\eta_n}{t_n}. \tag{49}$$

Below I show that

$$\left(\sum_{s\in\hat{N}}\frac{\eta_s}{\sqrt{t_s}}\right)^2-\left(\sum_{s\in\hat{N}}\frac{\eta_s}{t_s}\right)\left(\sum_{s\in\hat{N}}\eta_s\right)\le 0,$$

which implies that the sign of the right-hand side of (49) is always negative. To see this, it suffices to note that

$$\begin{aligned}\left(\sum_{s\in\hat{N}}\frac{\eta_s}{\sqrt{t_s}}\right)^2-\left(\sum_{s\in\hat{N}}\frac{\eta_s}{t_s}\right)\left(\sum_{s\in\hat{N}}\eta_s\right)&=\sum_{s\in\hat{N}}\frac{\eta_s^2}{t_s}+\sum_{s\in\hat{N}}\sum_{k\in\hat{N},k\neq s}\frac{\eta_s\eta_k}{\sqrt{t_s}\sqrt{t_k}}-\sum_{s\in\hat{N}}\frac{\eta_s^2}{t_s}-\sum_{s\in\hat{N}}\sum_{k\in\hat{N},k\neq s}\frac{\eta_s\eta_k}{t_s}\\&=\sum_{s,k\in\hat{N},k\neq s}\left[\eta_s\eta_k\left(\frac{2}{\sqrt{t_st_k}}-\frac{1}{t_s}-\frac{1}{t_k}\right)\right]<0.\end{aligned}$$

Along with the property that the set $\hat{N}$ of sources that receive strictly positive attention in equilibrium decreases with $\alpha$ (in the set inclusion order), the fact that, for given $\hat{N}$, $\sum_{s\in\hat{N}}\hat{z}_s$ is decreasing in $\alpha$ implies that $\hat{Z}$ decreases with $\alpha$. Q.E.D.

**Proof of Proposition 4.** I establish that the result in the proposition holds for general linear summary statistics of the individual signals. Formally, let $\lambda\equiv(\lambda_n(\cdot))_{n=1}^N$ be any collection of functions $\lambda_n:\mathbb{R}_+^N\to[0,1]$, one for each source $n=1,...,N$, such that, for any $z^j\in\mathbb{R}_+^N$, $\sum_{s=1}^N\lambda_s(z^j)=1$. Under this more general specification, the precision of the statistic $\tilde{X}^j$ is equal to

$$\pi_X(z^j)\equiv\left[\sum_{s=1}^N\lambda_s(z^j)^2\left(\pi_s(z^j)\right)^{-1}\right]^{-1}. \tag{50}$$

Furthermore, when any two agents $i,j\in[0,1]$, $j\neq i$, allocate the same attention $z^i=z^j=z$ to the sources, the correlation in the errors in $\tilde{X}^j$ and $\tilde{X}^j$ is given by

$$\begin{aligned}\rho_X(z)&\equiv Corr\left(\sum_{n=1}^N\lambda_n(z)(\tilde{\varepsilon}_n+\tilde{\xi}_n^i);\sum_{n=1}^N\lambda_n(z)(\tilde{\varepsilon}_n+\tilde{\xi}_n^j)\right)\\&=\sum_{n=1}^N\left(\frac{\lambda_n(z)^2\left(\pi_n(z)\right)^{-1}}{\sum_{s=1}^N\lambda_s(z)^2\left(\pi_s(z)\right)^{-1}}\right)\rho_n(z).\end{aligned} \tag{51}$$

First I prove that, when all agents allocate attention $z$ to the various sources of information, the continuation game that starts when the agents, after observing their summary statistic, must choose their actions, has a unique continuation equilibrium where the actions are given by $k^i = \mathrm{k}^{\#}(X^i; z)$ for all $i \in [0,1]$ all $X^i \in \mathbb{R}$, where, for any $z \in \mathbb{R}^N_+$, the function $\mathrm{k}^{\#}(\cdot; z) : \mathbb{R} \to \mathbb{R}$ is given by

$$\mathrm{k}^{\#}(X^i; z) \equiv \kappa_0 + \kappa_1 \gamma^{\#}(z) X^i, \tag{52}$$

with $\gamma^{\#}(z)$ as defined in (20). To see this, observe that the continuation game is identical to the one in Section 3, with the only difference that each agent receives a single uni-dimensional signal $X^i$ with precision $\pi_X(z)$ and endogenous publicity $\rho_X(z)$. Proposition 1 then implies that, in the unique continuation equilibrium of this game, each individual follows the rule in (52) to determine his action.

Next, I characterize the allocation of attention in any symmetric equilibrium. To this purpose, suppose that all agents $i \neq j$ allocate attention $z^i = z$ to the different sources of information and then use (52) to determine their actions. Let $U^j(z^j; z)$ denote the payoff of agent $j$ when he allocates attention $z^j$ to the different sources and then chooses optimally the mapping from the statistic $X^j$ to his actions. Using the envelope theorem, in any symmetric equilibrium with attention $z^{\#}$, for any source $n$ for which $z^{\#}_n > 0$, $\partial U^j(z^{\#}; z^{\#})/\partial z^j_n$ coincides with the partial derivative of the agent's expected payoff with respect to $z^j_n$, evaluated at $z^j = z^{\#}$, holding fixed the mapping $\mathrm{k}^{\#}(\cdot; z^{\#})$ from the agent's statistic $X^j$ to his actions and letting this mapping be the one in (52) with $z = z^{\#}$.[17]

Observe that, when, given $(z^j, z)$, all agents (including agent $j$) follow the rule in (52) to map their statistics into their actions, then agent $j$'s ex-ante expected payoff is equal to

$$\begin{aligned} &\mathbb{E}[u(\tilde{K}, \tilde{K}, \sigma_k, \tilde{\theta}) \mid z^j, z] + \mathbb{E}[u_k(\tilde{K}, \tilde{K}, \sigma_k, \tilde{\theta})(\tilde{k}^j - \tilde{K}) \mid z^j, z] \\ &\qquad + \frac{u_{kk}}{2} \mathbb{E}\left[\left(\tilde{k}^j - \tilde{K}\right)^2 \mid z^j, z\right] - C(z^j), \end{aligned} \tag{53}$$

where the first term in the right-hand side of (53) is the expected payoff of an agent whose action coincides with the average action

$$K = \kappa_0 + \kappa_1 \gamma^{\#}(z) \left(\theta + \sum\nolimits_{n=1}^{N} \lambda_n(z) \varepsilon_n\right)$$

in the population in every state. Importantly, note that, because the mapping $\mathrm{k}^{\#}(\cdot; z)$ is kept fixed, $\mathbb{E}[u(\tilde{K}, \tilde{K}, \sigma_k, \tilde{\theta}) \mid z^j, z]$ is invariant in the agent's own attention $z^j$. Next observe that

$$\mathbb{E}\left[\left(\tilde{k}^j - \tilde{K}\right)^2 \mid z^j, z\right] = \mathbb{E}\left[\left(\tilde{k}^j - \tilde{K}^j\right)^2 + (\tilde{K}^j - \tilde{K})^2 + 2\left(\tilde{k}^j - \tilde{K}^j\right)(\tilde{K}^j - \tilde{K}) \mid z^j, z\right],$$

where the random variable

$$\tilde{K}^j \equiv \kappa_0 + \kappa_1 \gamma^{\#}(z) \left[\tilde{\theta} + \sum\nolimits_{n=1}^{N} \lambda_n(z^j) \tilde{\varepsilon}_n\right]$$

is the agent's own expected action given $(\theta, \varepsilon)$, when his attention is $z^j$. Using the fact that, for any $(z^j, z)$,

$$\tilde{k}^j - \tilde{K}^j = \kappa_1 \gamma^{\#}(z) \sum\nolimits_{n=1}^{N} \lambda_n(z^j) \tilde{\xi}^j_n$$

is orthogonal to

$$\tilde{K}^j - \tilde{K} = \kappa_1 \gamma^{\#}(z) \sum\nolimits_{n=1}^{N} \left[\lambda_n(z^j) - \lambda_n(z)\right] \tilde{\varepsilon}_n,$$

I then have that

$$\begin{aligned} \frac{\partial}{\partial z^j_n} \mathbb{E}\left[\left(\tilde{k}^j - \tilde{K}\right)^2 \mid z, z\right] &= \frac{\partial}{\partial z^j_n} \mathbb{E}\left[\left(\tilde{k}^j - \tilde{K}^j\right)^2 \mid z, z\right] + \frac{\partial}{\partial z^j_n} \mathbb{E}\left[\left(\tilde{K}^j - \tilde{K}\right)^2 \mid z, z\right] \\ &= \frac{\partial}{\partial z^j_n} \mathbb{E}\left[\left(\tilde{k}^j - \tilde{K}^j\right)^2 \mid z, z\right] = \frac{\partial}{\partial z_n} Var\left[\tilde{k}^j - \tilde{K} \mid z\right], \end{aligned}$$

where

$$\tilde{k}^j - \tilde{K} = \kappa_1 \gamma^{\#}(z) \sum\nolimits_{n=1}^{N} \lambda_n(z) \tilde{\xi}^j_n,$$

and where all derivatives are computed holding the rule the agents follow to map their statistics into their actions fixed, with the latter given by (53) — in other words, without differentiating the coefficient $\gamma^{\#}(z)$. Note that the second equality follows from the fact that, when $z^j = z$, for any $(\theta, \varepsilon)$, $K^j = K$, whereas the third equality uses the fact that $\mathbb{E}\left[\tilde{\xi}^j_n \mid z, z\right] = 0$ for all $n = 1, ..., N$. Importantly, note that the derivative

$$\frac{\partial}{\partial z_n} Var\left[\tilde{k}^j - \tilde{K} \mid z\right] = \left(\kappa_1 \gamma^{\#}(z)\right)^2 \frac{\partial}{\partial z_n} Var\left[\sum\nolimits_{n=1}^{N} \lambda_n(z)^2 \tilde{\xi}^j_n \mid z\right]$$

[17] Furthermore, for any source for which $z^{\#}_n = 0$, the right-hand derivative $\partial U^j_+(z^{\#}; z^{\#})/\partial z^j_n$ coincides with the limit for $z_n \to 0^+$ of the derivative $\partial U^j((z_n, z^{\#}_{-n}); (z_n, z^{\#}_{-n}))/\partial z^j_n$ by continuity of the right-hand derivative, where $z^{\#}_{-n} \equiv (z^{\#}_1, ..., z^{\#}_{n-1}, z^{\#}_{n+1}, ..., z^{\#}_N)$.

is computed holding fixed the coefficient $\gamma^{\#}(z)$ in the rule (52) the agents follow to determine their actions, but accounting for the fact that a variation in $z_n$ affects the dispersion of individual actions around the mean action both directly by changing the distribution of the noise $\tilde{\xi}_n^j$ in signal $\tilde{x}_j$, and indirectly by changing the weights $\lambda_s(z)$ in the agents' statistics. The derivations above also establish that, in a symmetric equilibrium, the reduction of the dispersion of individual actions around the mean action is the same irrespective of whether one changes only the attention of agent $j$, or all agents' attention, as claimed in the main text.

Finally, consider the term $\mathbb{E}[u_k(\tilde{K},\tilde{K},\sigma_k,\tilde{\theta})(\tilde{k}^j-\tilde{K}) \mid z^j,z]$. Using the fact that

$$u_k(\tilde{K},\tilde{K},\sigma_k,\tilde{\theta}) = u_k(\tilde{\kappa},\tilde{\kappa},0,\tilde{\theta}) + \left(u_{kk}+u_{kK}\right)(\tilde{K}-\tilde{\kappa}),$$

along with the fact that, for any $\theta$, $u_k(\tilde{\kappa},\tilde{\kappa},0,\tilde{\theta})=0$ by definition of the complete-information equilibrium allocation $\tilde{\kappa}=\kappa_0+\kappa_1\tilde{\theta}$, I have that

$$\mathbb{E}[u_k(\tilde{K},\tilde{K},\sigma_k,\tilde{\theta})(\tilde{k}^j-\tilde{K}) \mid z^j,z] = \left(u_{kk}+u_{kK}\right)\mathbb{E}[(\tilde{K}-\tilde{\kappa})(\tilde{k}^j-\tilde{K}) \mid z^j,z] = \left(u_{kk}+u_{kK}\right)\mathbb{E}[(\tilde{K}-\tilde{\kappa})(\tilde{K}^j-\tilde{K}) \mid z^j,z]$$

where the second equality uses the fact that $\tilde{k}^j-\tilde{K}^j$ is orthogonal to $\tilde{K}-\tilde{\kappa}$. Next observe that

$$\begin{aligned}
&\frac{\partial}{\partial z_n^j}\mathbb{E}[(\tilde{K}-\tilde{\kappa})(\tilde{K}^j-\tilde{K}) \mid z,z] = \frac{\partial}{\partial z_n^j}\mathbb{E}\left[(\tilde{K}-\tilde{\kappa})\tilde{K}^j \mid z,z\right]\\
&= \frac{\partial}{\partial z_n^j}\mathbb{E}\left[\left(\tilde{K}-\tilde{\kappa}\right)\left(\kappa_0+\kappa_1\gamma^{\#}(z)\tilde{\theta}+\kappa_1\gamma^{\#}(z)\sum_{s=1}^N\lambda_s(z)\tilde{\varepsilon}_s\right) \mid z,z\right]\\
&= \mathbb{E}\left[\left(\tilde{K}-\tilde{\kappa}\right)\left(\kappa_1\gamma^{\#}(z)\sum_{s=1}^N\frac{\partial\lambda_s(z)}{\partial z_n^j}\tilde{\varepsilon}_s\right) \mid z,z\right]\\
&= \left(\kappa_1\gamma^{\#}(z)\right)^2\mathbb{E}\left[\left(\sum_{s=1}^N\lambda_s(z)\tilde{\varepsilon}_s\right)\left(\sum_{s=1}^N\frac{\partial\lambda_s(z)}{\partial z_n^j}\tilde{\varepsilon}_s\right) \mid z,z\right]\\
&= \left(\kappa_1\gamma^{\#}(z)\right)^2\sum_{s=1}^N\left(\lambda_s(z)\frac{\partial\lambda_s(z)}{\partial z_n^j}\right)\frac{1}{\eta_s},
\end{aligned}$$

where the first equality uses the fact that $\tilde{K}$ and $\tilde{\kappa}$ are invariant in $z^j$, the second equality uses the definition of $\tilde{K}^j$, the third equality uses the fact that $\gamma^{\#}(z)$ is held fixed in the differentiation, the fourth equality uses the fact that,

$$\tilde{K}-\tilde{\kappa} = \kappa_1\left(\gamma^{\#}(z)-1\right)\tilde{\theta}+\kappa_1\gamma^{\#}(z)\sum\nolimits_{s=1}^N\lambda_s(z)\tilde{\varepsilon}_s \tag{54}$$

together with the fact that $\tilde{\theta}$ is orthogonal to each $\tilde{\varepsilon}_s$, and the last equality uses the fact that each $\tilde{\varepsilon}_s$ is orthogonal any $\tilde{\varepsilon}_l$, $l\neq s$, has variance $1/\eta_s$ and is such that $\mathbb{E}[\tilde{\varepsilon}_s]=0$.

Let $\frac{\partial}{\partial z_n}Var\left[\tilde{K}-\tilde{\kappa} \mid z\right]$ denote the marginal change in the dispersion of $\tilde{K}$ around $\tilde{\kappa}$ that obtains when one changes the $n$-th component of $z$, holding fixed the rule mapping each agent's statistic $X^j$ into his action $k^j$ and letting this rule be the one in (53) – that is, in computing the derivative, the weight $\gamma^{\#}(z)$ is held fixed. Then use (54) to observe that

$$\begin{aligned}
&\frac{1}{2}\frac{\partial}{\partial z_n}Var\left[\tilde{K}-\tilde{\kappa} \mid z\right] \qquad (55)\\
&= \frac{1}{2}\frac{\partial}{\partial z_n}Var\left[\kappa_1\left(\gamma^{\#}(z)-1\right)\tilde{\theta}+\kappa_1\gamma^{\#}(z)\sum_{s=1}^N\lambda_s(z)\tilde{\varepsilon}_s \mid z\right]\\
&= \frac{\left(\kappa_1\gamma^{\#}(z)\right)^2}{2}\frac{\partial}{\partial z_n}Var\left[\sum_{s=1}^N\lambda_s(z)\varepsilon_s \mid z\right]\\
&= \frac{\left(\kappa_1\gamma^{\#}(z)\right)^2}{2}\frac{\partial}{\partial z_n}\left[\sum_{s=1}^N\lambda_s(z)^2\frac{1}{\eta_s}\right]\\
&= \left(\kappa_1\gamma^{\#}(z)\right)^2\left\{\sum_{s=1}^N\left(\lambda_s(z)\frac{\partial\lambda_s(z)}{\partial z_n}\right)\frac{1}{\eta_s}\right\}\\
&= \frac{\partial}{\partial z_n^j}\mathbb{E}[(\tilde{K}-\tilde{\kappa})(\tilde{K}^j-\tilde{K}) \mid z,z].
\end{aligned}$$

Combining the different pieces and using the fact that $|u_{kk}|(1-\alpha) = -(u_{kk}+u_{kK})$, I conclude that

$$\frac{\partial U^j(z;z)}{\partial z_n^j} = -\frac{|u_{kk}|}{2}\frac{\partial}{\partial z_n}Var\left[\tilde{k}^j-\tilde{K} \mid z\right] \tag{56}$$

$$-\frac{|u_{kk}|}{2}(1-\alpha)\frac{\partial}{\partial z_n}Var\left[\tilde{K}-\tilde{\kappa}\mid z\right]-C_n'(z).$$

In any symmetric equilibrium, for any source of information $n=1,...,N$ that receives strictly positive attention, it must be that the above derivative vanishes, which, after specializing the cost to the linear one in (2), yields (21) in the main text. The above properties also imply that, for any source that receives no attention, Condition (22) holds. Clearly, the second term in (21) disappears if the agent can choose his summary statistic $X$, for, in this case, by usual envelope arguments, the marginal benefit of increasing the attention to any source should be computed holding fixed both the selection of the summary statistic and the strategy that maps the latter into the selected action. When both the weights $\lambda$ defining the statistic $X^j$ and the mapping $\mathrm{k}^{\#}(\cdot;z)$ are held fixed, the average action is thus invariant in $z_n$.

Finally, note that the uniqueness of the symmetric equilibrium follows from arguments similar to those that establish uniqueness in the model with perfect recall; the proof is thus omitted for brevity. Q.E.D.

**Proof of Proposition 5.** In this proof I establish that the result in the proposition holds for the more general case where the functions $\lambda\equiv(\lambda_n(\cdot))_{n=1}^N$ governing the weights in the agents' statistics $X^j=\sum\lambda(z)x_n^j$ are given by $\lambda_n(z^j)=\lambda_n^\beta(z^j)$ for all $n=1,...,N$, all $z^j\in\mathbb{R}_+^N$, where

$$\lambda_n^\beta(z)\equiv\frac{\frac{\pi_n(z)}{1-\beta\alpha\rho_n(z)}}{\sum_{s=1}^N\frac{\pi_s(z)}{1-\beta\alpha\rho_s(z)}} \tag{57}$$

with $\beta\in[0,1]$. When $\beta=1$, the statistic $X^j$ permits the agents to play the same actions as under perfect recall. When, instead, $\beta=0$, what the agents recall is their posterior belief about the fundamentals $\theta$, as assumed in the main text. More generally, when $\beta\in(0,1)$, the strategic relevance of each source $n$, as captured by the term $\alpha\rho_n$, is discounted in favor of the source's accuracy $\pi_n$.

The proof is in four steps. Step 1 shows how, starting from a situation where all agents assign attention $z$ to the various sources, the net benefit of increasing the attention allocated to any source $n$ depends on the primitive parameters of the model. The characterization applies to any statistic $X^j$ summarizing the agents' information. Step 2 then uses the characterization in Step 1 to compare the benefit in the benchmark with perfect recall (equivalently, when the agents can choose their summary statistics) and in the case of bounded recall when the statistic is exogenous. Step 3 shows how the comparison in Step 2 specializes in the case where the exogenous statistic $X^j$ takes the form in (57). Finally, step 4 shows that $0<\rho'<\rho''<1$ for $\alpha$ large enough and $\beta$ small enough.

*Step 1.* Suppose all agents assign attention $z$ to the sources. Under bounded recall, the marginal benefit of increasing the attention to any source $n$ is given by (56). Below, I express the various terms in (56) as a function of the key parameters. To simplify the exposition, I drop $z$ from the arguments of the various functions, when there is no risk of confusion.

First observe that

$$\frac{\partial}{\partial z_n}Var\left[\tilde{k}^j-\tilde{K}\mid z\right]=\left(\kappa_1\gamma^{\#}\right)^2\frac{\partial}{\partial z_n}Var\left(\sum_{s=1}^N\lambda_s\tilde{\xi}_s\right).$$

Using the fact that

$$\frac{\partial}{\partial z_n}Var\left(\sum_{s=1}^N\lambda_s\tilde{\xi}_s\right)=\frac{\partial}{\partial z_n}\left[\sum_{s=1}^N\frac{\lambda_s^2}{t_sz_s}\right]=\sum_{s=1}^N\frac{2\lambda_s}{t_sz_s}\frac{\partial\lambda_s}{\partial z_n}-\frac{\lambda_n^2}{t_n\left(z_n\right)^2},$$

I have that

$$\frac{\partial}{\partial z_n}Var\left[\tilde{k}^j-\tilde{K}\mid z\right]=\left(\kappa_1\gamma^{\#}\right)^2\left\{\sum_{s=1}^N\frac{2\lambda_s}{t_sz_s}\frac{\partial\lambda_s}{\partial z_n}-\frac{\lambda_n^2}{t_n\left(z_n\right)^2}\right\}. \tag{58}$$

Next, use (55) to observe that

$$\frac{\partial}{\partial z_n}var\left[\tilde{K}-\tilde{\kappa}\mid z\right]=\left(\kappa_1\gamma^{\#}\right)^2\left\{\sum_{s=1}^N\frac{2\lambda_s}{\eta_s}\frac{\partial\lambda_s}{\partial z_n}\right\}. \tag{59}$$

Substituting (58) and (59) into (56), I conclude that, for any source $n$ and any allocation of attention $z$,

$$\begin{aligned}\frac{\partial U^j(z;z)}{\partial z_n^j}=&-|u_{kk}|\left(\kappa_1\gamma^{\#}\right)^2\left\{\sum_{s=1}^N\frac{\lambda_s}{t_sz_s}\frac{\partial\lambda_s}{\partial z_n}-\frac{1}{2}\frac{\lambda_n^2}{t_n\left(z_n\right)^2}\right\}\\&-|u_{kk}|(1-\alpha)\left(\kappa_1\gamma^{\#}\right)^2\left\{\sum_{s=1}^N\frac{\lambda_s}{\eta_s}\frac{\partial\lambda_s}{\partial z_n}\right\}-C_n'(z).\end{aligned} \tag{60}$$

Next, observe that

$$t_sz_s=\frac{\pi_s}{1-\rho_s}\quad\text{and}\quad\eta_s=\frac{\pi_s}{\rho_s}.$$

The benefit of increasing (locally) the attention to source $n$ is thus equal to

$$\frac{\partial U^j(z;z)}{\partial z_n^j} = |u_{kk}| \left(\kappa_1 \gamma^{\#}\right)^2 \left\{ \frac{\lambda_n^2}{2t_n\left(z_n\right)^2} - \sum_{s=1}^{N} \frac{(1-\alpha\rho_s)\lambda_s}{\pi_s} \frac{\partial \lambda_s}{\partial z_n} \right\} - C_n'(z). \tag{61}$$

*Step 2.* I now turn to the comparison between the benefit of increasing the attention to source $n$ in the benchmark of perfect recall and in the case of bounded recall.

In the case of perfect recall (equivalently, when the sufficient statistic is chosen optimally by the agents), the value of increasing the attention to any source $n$ is equal to (see the end of the proof of Proposition 1)

$$\frac{\partial U^j(z;z)}{\partial z_n^j} = |u_{kk}| \left(\kappa_1\right)^2 \left( \frac{\frac{(1-\alpha)\pi_n}{1-\alpha\rho_n}}{\pi_\theta + \sum_{s=1}^{N} \frac{(1-\alpha)\pi_s}{1-\alpha\rho_s}} \right)^2 \frac{1}{2t_n\left(z_n\right)^2} - C_n'(z). \tag{62}$$

Comparing (61) with (62), it is then easy to see that the benefit is larger under bounded recall if

$$\frac{\left(\lambda_n\right)^2\left(\gamma^{\#}\right)^2}{2t_n\left(z_n\right)^2} - \left(\gamma^{\#}\right)^2 \sum_{s=1}^{N} \frac{(1-\alpha\rho_s)\lambda_s}{\pi_s} \frac{\partial \lambda_s}{\partial z_n} > \left( \frac{\frac{(1-\alpha)\pi_n}{1-\alpha\rho_n}}{\pi_\theta + \sum_{s=1}^{N} \frac{(1-\alpha)\pi_s}{1-\alpha\rho_s}} \right)^2 \frac{1}{2t_n\left(z_n\right)^2}$$

and lower if the inequality is reversed. The above inequality can be rearranged as

$$\frac{\left(\lambda_n\right)^2(1-\alpha\rho_n)^2}{\left(\pi_n\right)^2} - \frac{2t_n\left(z_n\right)^2(1-\alpha\rho_n)^2}{\left(\pi_n\right)^2} \sum_{s=1}^{N} \frac{(1-\alpha\rho_s)\lambda_s}{\pi_s} \frac{\partial \lambda_s}{\partial z_n} > \frac{(1-\alpha)^2}{\left(\pi_\theta + \sum_{s=1}^{N} \frac{(1-\alpha)\pi_s}{1-\alpha\rho_s}\right)^2 \left(\gamma^{\#}\right)^2}. \tag{63}$$

*Step 3.* When the weights are as in (57), the inequality in (63) reduces to

$$\left(\frac{1-\alpha\rho_n}{1-\beta\alpha\rho_n}\right)^2 - \frac{2t_n\left(z_n\right)^2\left(1-\alpha\rho_n\right)^2}{\left(\pi_n\right)^2} \left(\sum_{l=1}^{N} \frac{\pi_l}{1-\beta\alpha\rho_l}\right) \sum_{s=1}^{N} \frac{1-\alpha\rho_s}{1-\beta\alpha\rho_s} \frac{\partial \lambda_s}{\partial z_n} > \frac{(1-\alpha)^2 \left(\sum_{l=1}^{N} \frac{\pi_l}{1-\beta\alpha\rho_l}\right)^2}{\left(\pi_\theta + \sum_{s=1}^{N} \frac{(1-\alpha)\pi_s}{1-\alpha\rho_s}\right)^2 \left(\gamma^{\#}\right)^2}. \tag{64}$$

Furthermore,

$$\frac{\partial \lambda_s}{\partial z_n} = \left[ \frac{\partial \lambda_s}{\partial \pi_n} + \frac{\partial \lambda_s}{\partial \rho_n} \frac{1}{\eta_n} \right] \frac{\partial \pi_n}{\partial z_n},$$

with

$$\frac{\partial \pi_n}{\partial z_n} = \frac{\pi_n^2}{t_n\left(z_n\right)^2},$$

$$\frac{\partial \lambda_s}{\partial \pi_n} = \begin{cases} -\dfrac{\frac{\pi_s}{1-\beta\alpha\rho_s} \frac{1}{1-\beta\alpha\rho_n}}{\left[\sum_{l=1}^{N} \frac{\pi_l}{1-\beta\alpha\rho_l}\right]^2} & \text{if } s \neq n, \\ \dfrac{\frac{1}{1-\beta\alpha\rho_n}}{\sum_{l=1}^{N} \frac{\pi_l}{1-\beta\alpha\rho_l}} - \dfrac{\frac{\pi_n}{\left(1-\beta\alpha\rho_n\right)^2}}{\left[\sum_{l=1}^{N} \frac{\pi_l}{1-\beta\alpha\rho_l}\right]^2} & \text{if } s = n, \end{cases}$$

and

$$\frac{\partial \lambda_s}{\partial \rho_n} = \begin{cases} -\dfrac{\frac{\pi_s}{1-\beta\alpha\rho_s} \frac{\pi_n \alpha\beta}{\left(1-\beta\alpha\rho_n\right)^2}}{\left[\sum_{l=1}^{N} \frac{\pi_l}{1-\beta\alpha\rho_l}\right]^2} & \text{if } s \neq n, \\ \dfrac{\frac{\pi_n \beta\alpha}{\left(1-\beta\alpha\rho_n\right)^2}}{\sum_{l=1}^{N} \frac{\pi_l}{1-\beta\alpha\rho_l}} - \dfrac{\frac{\pi_s}{1-\beta\alpha\rho_s} \frac{\pi_n \alpha\beta}{\left(1-\beta\alpha\rho_n\right)^2}}{\left[\sum_{l=1}^{N} \frac{\pi_l}{1-\beta\alpha\rho_l}\right]^2} & \text{if } s = n. \end{cases}$$

Using the above expressions along with the fact that $1/\eta_n = \rho_n/\pi_n$, I can rewrite the inequality in (64) as

$$\left(\frac{1-\alpha\rho_n}{1-\beta\alpha\rho_n}\right)^2 - 2\left(1-\alpha\rho_n\right)^2 \left(\sum_{l=1}^{N} \frac{\pi_l}{1-\beta\alpha\rho_l}\right) \sum_{s=1}^{N} \left\{ \frac{1-\alpha\rho_s}{1-\beta\alpha\rho_s} \left[ \frac{\partial \lambda_s}{\partial \pi_n} + \frac{\partial \lambda_s}{\partial \rho_n} \frac{\rho_n}{\pi_n} \right] \right\}$$

$$> \frac{(1-\alpha)^2\left(\sum_{l=1}^{N}\frac{\pi_l}{1-\beta\alpha\rho_l}\right)^2}{\left(\pi_\theta+\sum_{s=1}^{N}\frac{(1-\alpha)\pi_s}{1-\alpha\rho_s}\right)^2\left(\gamma^{\#}\right)^2}, \tag{65}$$

with

$$\sum_{s=1}^{N}\left\{\frac{1-\alpha\rho_s}{1-\beta\alpha\rho_s}\left[\frac{\partial\lambda_s}{\partial\pi_n}+\frac{\partial\lambda_s}{\partial\rho_n}\frac{\rho_n}{\pi_n}\right]\right\}=\frac{\frac{1-\alpha\rho_n}{(1-\beta\alpha\rho_n)^3}}{\sum_{l=1}^{N}\frac{\pi_l}{1-\beta\alpha\rho_l}}-\frac{1}{(1-\beta\alpha\rho_n)^2}\frac{\sum_{s=1}^{N}\frac{\pi_s(1-\alpha\rho_s)}{(1-\beta\alpha\rho_s)^2}}{\left(\sum_{l=1}^{N}\frac{\pi_l}{1-\beta\alpha\rho_l}\right)^2}.$$

After some simplifications, the inequality in (65) thus reduces to

$$2\left(\frac{1-\alpha\rho_n}{1-\beta\alpha\rho_n}\right)+\frac{(1-\alpha)^2\left(\sum_{l=1}^{N}\frac{\pi_l}{1-\beta\alpha\rho_l}\right)^2}{\left(\pi_\theta+\sum_{s=1}^{N}\frac{(1-\alpha)\pi_s}{1-\alpha\rho_s}\right)^2\left(\gamma^{\#}\right)^2}\frac{1}{\left(\frac{1-\alpha\rho_n}{1-\beta\alpha\rho_n}\right)^2}<1+2\frac{\sum_{s=1}^{N}\frac{\pi_s(1-\alpha\rho_s)}{(1-\beta\alpha\rho_s)^2}}{\sum_{l=1}^{N}\frac{\pi_l}{1-\beta\alpha\rho_l}}. \tag{66}$$

Now observe that the left-hand side of (66) is strictly convex in $\left(1-\alpha\rho_n\right)/\left(1-\beta\alpha\rho_n\right)$. Furthermore, $\left(1-\alpha\rho_n\right)/\left(1-\beta\alpha\rho_n\right)$ is decreasing in $\rho_n$. This means that there exist $\rho',\rho''\in[0,1]$ with $0\le\rho'\le\rho''\le 1$ such that the inequality in (66) holds if and only if $\rho_n\in[\rho',\rho'']$, whereas the opposite inequality holds if and only if $\rho_n\notin[\rho',\rho'']$.

*Step 4.* Observe that, when $\beta=0$, i.e., when the statistic $X^j$ coincides with the projection of $\theta$ on $x$, as assumed in the main text, the inequality in (66) reduces to

$$2\alpha(\rho_n-\rho_X^0)>\left(\frac{\pi_\theta+\frac{(1-\alpha)\pi_X^0}{1-\alpha\rho_X^0}}{\pi_\theta+\sum_{s=1}^{N}\frac{(1-\alpha)\pi_s}{1-\alpha\rho_s}}\right)^2\frac{\left(1-\alpha\rho_X^0\right)^2}{\left(1-\alpha\rho_n\right)^2}-1, \tag{67}$$

with $\pi_X^0\equiv\sum_{s=1}^{N}\pi_s$ and $\rho_X^0\equiv\sum_{s=1}^{N}\frac{\pi_s}{\pi_X^0}\rho_s$. Then note that the function defined by

$$f(\rho)\equiv\frac{1}{1-\alpha\rho}$$

is convex. Hence, by Jensen inequality,

$$\sum_{s=1}^{N}\frac{\pi_s}{\pi_X^0}\frac{1}{1-\alpha\rho_s}>\frac{1}{1-\alpha\rho_X^0},$$

which implies that

$$\left(\frac{\pi_\theta+\frac{(1-\alpha)\pi_X^0}{1-\alpha\rho_X^0}}{\pi_\theta+\sum_{s=1}^{N}\frac{(1-\alpha)\pi_s}{1-\alpha\rho_s}}\right)^2<1.$$

It follows that the inequality in (67) always holds for sources for which $|\rho_n-\rho_X^0|$ is small, implying that $\rho'<\rho_X^0<\rho''$. Also note that, when $\alpha=1$, the inequality in (67) is reversed for $\rho_n$ close to 1. By continuity, $\rho''<1$ for $\alpha$ large. Likewise, one can verify that, for $\alpha$ large, the inequality in (67) can be reversed when evaluated at $\rho_n$ close to zero. This means that $0<\rho'<\rho''<1$ for $\alpha$ large enough and $\beta$ small enough. Q.E.D.

**Proof of Corollary 3.** In this proof I show that the result in the corollary holds for any cost function $C$ that depends on total attention. That is, suppose there exists an increasing, convex, and differentiable function $c:\mathbb{R}_+\to\mathbb{R}_+$ such that, for any $z\in\mathbb{R}_+^N$, $C(z)=c\left(\sum_{n=1}^{N}z_n\right)$. The result then follows from Proposition 5 along with the fact that, when the attention cost depends only on total attention, then, under perfect recall, there is an increasing relationship between the exogenous transparency of the sources and their endogenous publicity. Namely, if $t_n>t_{n'}$, then $\rho_n(\hat{z})\ge\rho_{n'}(\hat{z})$. To see this, use the results in the proof of Corollary 1 to see that

$$\hat{z}_n=\frac{\eta_n}{\sqrt{t_n}(1-\alpha)}\max\left\{\hat{T}-\frac{1}{\sqrt{t_n}};0\right\}, \tag{68}$$

where

$$\hat{T}\equiv(1-\alpha)\sqrt{\frac{|u_{kk}|\kappa_1^2}{2c'(\hat{Z})}}\frac{1}{\hat{M}_1}, \tag{69}$$

with

$$\hat{Z} \equiv \sum_{l=1}^{N} \hat{z}_l, \tag{70}$$

and

$$\hat{M}_1 \equiv \pi_\theta + \sum_{l=1}^{N} \frac{(1-\alpha)\eta_l \hat{z}_l t_l}{(1-\alpha)\hat{z}_l t_l + \eta_l}. \tag{71}$$

Clearly, for all sources for which $t_n \leq 1/\hat{T}^2$, $\hat{z}_n = 0$ and hence $\rho_n(\hat{z}) = 0$. On the other hand, for all sources for which $t_n > 1/\hat{T}^2$,

$$\rho_n(\hat{z}) = \frac{\hat{z}_n t_s}{\hat{z}_n t_n + \eta_n} = \frac{\sqrt{t_n}\hat{T} - 1}{\sqrt{t_n}\hat{T} - \alpha}$$

which is increasing in $t_n$. Q.E.D.

**Proof of Proposition 6.** In this proof, I establish that the result in the proposition holds for any cost function $C$ that depends on total attention (i.e., such that, for any $z \in \mathbb{R}_+^N$, $C(z) = c\left(\sum_{n=1}^N z_n\right)$, for some increasing, convex, and differentiable function $c : \mathbb{R}_+ \to \mathbb{R}_+$).

Use (61) to observe that, in any equilibrium with *bounded* recall, for any source $n$ for which $z_n^\# > 0$, the following condition must hold

$$|u_{kk}| \left(\kappa_1 \gamma^\#\right)^2 \left\{ \frac{\left(\lambda_n^\#\right)^2}{2t_n \left(z_n^\#\right)^2} - \sum_{s=1}^{N} \frac{(1-\alpha\rho_s^\#)\lambda_s^\#}{\pi_s^\#} \frac{\partial \lambda_s^\#}{\partial z_n} \right\} = C_n'(z^\#), \tag{72}$$

where $\gamma^\#$, $\pi_s^\#$, $\rho_s^\#$, $\lambda_s^\#$ are shortcuts for $\gamma^\#(z^\#)$, $\pi_s(z^\#)$, $\rho_s(z^\#)$, and $\lambda_s(z^\#)$, respectively.

When the weights in the statistic $X^j$ are those in (57) and the cost $C$ depends only on total attention, the above condition reduces to

$$|u_{kk}| \left(\kappa_1 \gamma^\#\right)^2 \left\{ \frac{\left(\frac{\pi_n^\#}{1-\alpha\beta\rho_n^\#}\right)^2}{\left(\sum_{l=1}^N \frac{\pi_l^\#}{1-\alpha\beta\rho_l^\#}\right)^2 2t_n \left(z_n^\#\right)^2} - \frac{\sum_{s=1}^N \frac{1-\alpha\rho_s^\#}{1-\alpha\beta\rho_s^\#} \frac{\partial \lambda_s^\#}{\partial z_n}}{\sum_{l=1}^N \frac{\pi_l^\#}{1-\alpha\beta\rho_l^\#}} \right\} = c'(Z^\#), \tag{73}$$

where $Z^\# \equiv \sum_{l=1}^N z_l^\#$. Furthermore, as shown in the proof of Proposition 5, when the weights in $X^j$ are those in (57),

$$\frac{\partial \lambda_s}{\partial z_n} = \left[\frac{\partial \lambda_s}{\partial \pi_n} + \frac{\partial \lambda_s}{\partial \rho_n}\frac{1}{\eta_n}\right]\frac{\partial \pi_n}{\partial z_n} = \left[\frac{\partial \lambda_s}{\partial \pi_n} + \frac{\partial \lambda_s}{\partial \rho_n}\frac{\rho_n}{\pi_n}\right]\frac{\pi_n^2}{t_n \left(z_n\right)^2}$$

and

$$\sum_{s=1}^{N} \left\{ \frac{1-\alpha\rho_s}{1-\beta\alpha\rho_s} \left[\frac{\partial \lambda_s}{\partial \pi_n} + \frac{\partial \lambda_s}{\partial \rho_n}\frac{\rho_n}{\pi_n}\right] \right\} = \frac{\frac{1-\alpha\rho_n}{(1-\beta\alpha\rho_n)^3}}{\sum_{l=1}^N \frac{\pi_l}{1-\beta\alpha\rho_l}} - \frac{\sum_{s=1}^N \frac{\pi_s(1-\alpha\rho_s)}{(1-\beta\alpha\rho_s)^2}}{(1-\beta\alpha\rho_n)^2 \left(\sum_{l=1}^N \frac{\pi_l}{1-\beta\alpha\rho_l}\right)^2}.$$

It follows that Condition (73) can be rewritten as

$$\frac{1}{2} - \frac{1-\alpha\rho_n^\#}{1-\beta\alpha\rho_n^\#} + \frac{\sum_{s=1}^N \frac{\pi_s^\#(1-\alpha\rho_s^\#)}{(1-\beta\alpha\rho_s^\#)^2}}{\sum_{l=1}^N \frac{\pi_l^\#}{1-\beta\alpha\rho_l^\#}} = \frac{c'(Z^\#)\left(\sum_{l=1}^N \frac{\pi_l^\#}{1-\beta\beta\rho_l^\#}\right)^2 t_n \left(z_n^\#\right)^2 (1-\beta\alpha\rho_n^\#)^2}{|u_{kk}| \left(\kappa_1\gamma^\#\right)^2 \left(\pi_n^\#\right)^2}.$$

In the special case in which $\beta = 0$, the above condition reduces to

$$\frac{1}{2} + \alpha\left(\rho_n^\# - \rho_X^\#\right) = \frac{c'(Z^\#)\left(\pi_X^\#\right)^2 t_n \left(z_n^\#\right)^2}{|u_{kk}| \left(\kappa_1\gamma^\#\right)^2 \left(\pi_n^\#\right)^2}, \tag{74}$$

from which I obtain that

$$z_n^\# = \sqrt{\frac{|u_{kk}|}{c'(Z^\#)}} \frac{\kappa_1 \gamma^\# \left(\pi_n^\#\right)}{\pi_X^\# \sqrt{t_n}} \sqrt{\frac{1}{2} + \alpha\left(\rho_n^\# - \rho_X^\#\right)}.$$

Using

$$\rho_n^\# = \frac{z_n^\# t_n}{z_n^\# t_n + \eta_n} \text{ and } \pi_n^\# \equiv \frac{\eta_n z_n^\# t_n}{z_n^\# t_n + \eta_n},$$

I conclude that, for any source $n$ that receives strictly positive attention in the equilibrium with bounded recall,

$$z_n^{\#} = \frac{\eta_n}{\sqrt{t_n}} \left\{ A^{\#} \sqrt{B^{\#} + \alpha \rho_n^{\#}} - \frac{1}{\sqrt{t_n}} \right\},$$

where

$$A^{\#} \equiv \sqrt{\frac{|u_{kk}|}{c'(Z^{\#})}} \frac{\kappa_1 \gamma^{\#}}{\pi_X^{\#}} \text{ and } B^{\#} \equiv \frac{1}{2} - \alpha \rho_X^{\#}.$$

Furthermore, for any source that receives no attention in the equilibrium with bounded recall, the following condition must hold

$$u_{kk} |\left(\kappa_1 \gamma^{\#}\right)^2 \left\{ \frac{\left(\lambda_n^{\#}\right)^2}{2 t_n \left(z_n^{\#}\right)^2} - \sum_{s=1}^{N} \frac{(1 - \alpha \rho_s^{\#}) \lambda_s^{\#}}{\pi_s^{\#}} \frac{\partial \lambda_s^{\#}}{\partial z_n} \right\} \leq C_n'(z^{\#}),$$

which, using the derivations above, reduces to

$$c'(Z^{\#}) \geq \frac{|u_{kk}| \left(\kappa_1 \gamma^{\#}\right)^2}{\left(\pi_X^{\#}\right)^2} t_n B^{\#}.$$

Next, use (68) to observe that, when $C(z) = c(\sum_{l=1}^{N} z_l)$, in the equilibrium with *perfect* recall, for any source $n$,

$$\hat{z}_n = \frac{\eta_n}{\sqrt{t_n}(1 - \alpha)} \max \left\{ \hat{T} - \frac{1}{\sqrt{t_n}}; 0 \right\}$$

where

$$\hat{T} \equiv (1 - \alpha) \sqrt{\frac{|u_{kk}| \left(\kappa_1\right)^2}{2 c'(\hat{Z})}} \frac{1}{M_1(\hat{z})}$$

with $\hat{Z} \equiv \sum_{l=1}^{N} \hat{z}_l$ and

$$M_1(\hat{z}) \equiv \pi_\theta + \sum_{l=1}^{N} \frac{(1 - \alpha) \eta_l \hat{z}_l t_l}{(1 - \alpha) \hat{z}_l t_l + \eta_l}.$$

From the above observations, I conclude that

$$z_n^{\#} > \hat{z}_n \;\Rightarrow\; A^{\#} \sqrt{B^{\#} + \alpha \rho_n^{\#}} + \frac{\alpha}{1 - \alpha} \frac{1}{\sqrt{t_n}} > \frac{\hat{T}}{1 - \alpha}, \tag{75}$$

and

$$0 < z_n^{\#} < \hat{z}_n \;\Rightarrow\; A^{\#} \sqrt{B^{\#} + \alpha \rho_n^{\#}} + \frac{\alpha}{1 - \alpha} \frac{1}{\sqrt{t_n}} < \frac{\hat{T}}{1 - \alpha}. \tag{76}$$

Finally, use the definition of the publicity of a source to observe that, for any source $n$ for which $z_n^{\#} > 0$,

$$\rho_n^{\#} = 1 - \frac{1}{A^{\#} \sqrt{t_n} \sqrt{B^{\#} + \alpha \rho_n^{\#}}}. \tag{77}$$

That is, the publicity $\rho_n^{\#}$ of any source that receives some attention in the equilibrium with bounded recall must solve the following equation:

$$\left[1 - \rho_n^{\#}\right] \sqrt{B^{\#} + \alpha \rho_n^{\#}} = \frac{1}{A^{\#} \sqrt{t_n}}. \tag{78}$$

Next observe that the left-hand-side of Condition (78) is decreasing in $\rho$ when $\alpha \leq 0$. In this case, Condition (78) implicitly defines an increasing function $\rho^{\#}(t)$ between the transparency $t$ and the publicity $\rho^{\#}$ of those sources that receive strictly positive attention in the equilibrium with bounded recall. The same is true when $\alpha > 0$. To see this, fix $B^{\#}$, let

$$\underline{\rho}^{\#} \equiv \begin{cases} 0 \text{ if } B^{\#} \geq 0 \\ -\frac{B^{\#}}{\alpha} \text{ if } B^{\#} < 0 \end{cases}$$

and note that the function $h(\rho) \equiv (1 - \rho) \sqrt{B^{\#} + \alpha \rho}$ defined by the left-hand-side of Condition (78) (a) is defined over $[\underline{\rho}^{\#}, 1]$, (b) is non-negative, (c) satisfies $h(1) = 0$ and $h(\underline{\rho}^{\#}) = 0$ when $\underline{\rho}^{\#} > 0$ and $h(\underline{\rho}^{\#}) > 0$ when $\underline{\rho}^{\#} = 0$, and (d) is concave. The above properties

imply that $h(\cdot)$ is either decreasing over $[\underline{\rho}^{\#},1]$, or it inverted U-shaped with a stationary point $\rho^{s}\in(\underline{\rho}^{\#},1)$. In this latter case, Condition (78) may admit two solutions. However, when this is the case, it is always the largest one that identifies the equilibrium publicity of the source. To see this, observe that, when $h$ is decreasing over $[\underline{\rho}^{\#},1]$, the unique solution to the equation defined by Condition (78) is such that $h(\rho)>1/(A^{\#}\sqrt{t_n})$ for $\rho<\rho_n^{\#}$ and $h(\rho)<1/(A^{\#}\sqrt{t_n})$ for $\rho>\rho_n^{\#}$. This means that, for the agent's payoff to reach at a global maximum at $z_n=z_n^{\#}$ or, equivalently, for $\rho_n^{\#}$ to be the equilibrium publicity of the source, it must be that $h$ is locally decreasing at the equilibrium level $\rho_n^{\#}$.

I conclude that, irrespective of the sign of $\alpha$, Condition (78) identifies an increasing relationship $\rho^{\#}(\cdot)$ between the endogenous publicity $\rho_n^{\#}$ and the transparency $t_n$ of the sources that receive strictly positive attention in the equilibrium with bounded recall, with the relationship $\rho^{\#}(\cdot)$ given by the highest solution to the equation in Condition (78).

Now let $[\underline{t},+\infty)$ denote the set of transparency levels for which the equation in Condition (78) admits a solution. Then observe that, over $[\underline{t},+\infty)$, the highest solution to the equation in Condition (78) identifies a differentiable function with

$$\frac{\partial\rho^{\#}(t)}{\partial t}=\frac{\left[B^{\#}+\alpha\rho^{\#}(t)\right]\left[1-\rho^{\#}(t)\right]}{t\left\{2\left[B^{\#}+\alpha\rho^{\#}(t)\right]-\left[1-\rho^{\#}(t)\right]\alpha\right\}}.$$

Then, for any $t\in[\underline{t},+\infty)$, let $\Lambda(t)$ be the function defined by

$$\Lambda(t)=A^{\#}\sqrt{B^{\#}+\alpha\rho^{\#}(t)}+\frac{\alpha}{1-\alpha}\frac{1}{\sqrt{t}}=\frac{1}{\left[1-\rho^{\#}(t)\right]\sqrt{t}}+\frac{\alpha}{1-\alpha}\frac{1}{\sqrt{t}} \tag{79}$$

with $\rho^{\#}(t)$ denoting the increasing function implicitly defined by the highest solution to the equation in Condition (78). The function $\Lambda(\cdot)$ is differentiable over $[\underline{t},+\infty)$ with

$$\begin{aligned}\Lambda'(t)&=\frac{1}{\left[1-\rho^{\#}(t)\right]^{2}t}\left\{\frac{\partial\rho^{\#}(t)}{\partial t}\sqrt{t}-\frac{1-\rho^{\#}(t)}{2\sqrt{t}}\right\}-\frac{\alpha}{(1-\alpha)2t\sqrt{t}}\\&=\frac{\alpha}{2t\sqrt{t}}\left\{\frac{1}{2B^{\#}-\alpha+3\alpha\rho^{\#}(t)}-\frac{1}{1-\alpha}\right\}.\end{aligned}$$

Note that, irrespective of the sign of $\alpha$, because $\rho^{\#}(t)$ is non-decreasing, $\Lambda(t)$ is quasi-concave, meaning that either $\Lambda'(t)$ is of constant sign, or there exists $t^{\#}$ such that $\Lambda'(t)>0$ for $t<t^{\#}$ and $\Lambda'(t)<0$ if $t>t^{\#}$. The quasi-concavity of $\Lambda(t)$ is clearly preserved when the function $\Lambda(t)$ is restricted to the set $\left\{t_n:\ n=1,...,N \text{ and } z_n^{\#}>0\right\}$. Because $\Lambda(t)$ coincides with the left-hand side of the inequalities in (75) and (76) that are responsible for whether $z_n^{\#}>\hat{z}_n$ or $0<z_n^{\#}<\hat{z}_n$, I then conclude that, among those sources that receive attention under bounded recall, one of the following must be true: (a) $z_n^{\#}>\hat{z}_n$ for all $n$; (b) $z_n^{\#}<\hat{z}_n$ for all $n$; (c) there exists $t_1$ such that $z_n^{\#}>\hat{z}_n$ for those $n$ for which $t_n<t_1$ and $z_n^{\#}<\hat{z}_n$ for those $n$ for which $t_n>t_1$; (d) there exists $t_2$ such that $z_n^{\#}>\hat{z}_n$ for those $n$ for which $t_n>t_2$ and $z_n^{\#}<\hat{z}_n$ for those $n$ for which $t_n<t_2$; (e) there exist thresholds $t_1$ and $t_2$ such that $z_n^{\#}>\hat{z}_n$ for those $n$ for which $t_n\in(t_1,t_2)$ and $z_n^{\#}<\hat{z}_n$ for those $n$ for which $t_n\notin(t_1,t_2)$. All these various cases can be summarized concisely by saying that there exist thresholds $t'$ and $t''$ such that the properties in the proposition hold. Q.E.D.

**Proof of Proposition 7.** The result in the proposition is established by comparing the private to the social (gross) marginal benefit of increasing the attention to any given source $n$, starting from the attention $z^{\#}$ to the sources in the unique symmetric equilibrium with bounded recall. The social benefit is the increase in the ex-ante expected utility of a representative agent when information is used efficiently, i.e., according to the rule $\mathrm{k}^{**}(\cdot|z^{\#})$ in (23).

Fix the equilibrium allocation of attention $z^{\#}$. Using (21) and (26), I have that, starting from $z^{\#}$, the private and the social marginal benefits of increasing the attention to any source $n$ are given by

$$PB_n(z^{\#})=-\frac{|u_{kk}|}{2}\frac{\partial}{\partial z_n}Var\left[\tilde{k}^{j}-\tilde{K}\mid z^{\#}\right]-\frac{|u_{kk}|}{2}(1-\alpha)\frac{\partial}{\partial z_n}Var\left[\tilde{K}-\tilde{\kappa}\mid z^{\#}\right]$$

and

$$\begin{aligned}SB_n(z^{\#})=&-\frac{|u_{kk}+u_{\sigma\sigma}|}{2}\frac{\partial}{\partial z_n}Var^{**}\left[\tilde{k}^{j}-\tilde{K}\mid z^{\#}\right]\\&-\frac{|u_{kk}+u_{\sigma\sigma}|}{2}(1-\alpha^{*})\frac{\partial}{\partial z_n}Var^{**}\left[\tilde{K}-\tilde{\kappa}^{*}\mid z^{\#}\right]\end{aligned}$$

respectively. Note that I use the notation $Var^{**}\left[\tilde{k}^{j}-\tilde{K}\mid z^{\#}\right]$ and $Var^{**}\left[\tilde{K}-\tilde{\kappa}\mid z^{\#}\right]$ to highlight that these variances are for the case where the agents' actions are determined by the efficient rule $\mathrm{k}^{**}(\cdot|z^{\#})$, whereas the variances $Var\left[\tilde{k}^{j}-\tilde{K}\mid z^{\#}\right]$ and $Var\left[\tilde{K}-\tilde{\kappa}\mid z^{\#}\right]$ are for the case where the agents' actions are determined by the equilibrium rule $\mathrm{k}^{\#}(\cdot|z^{\#})$. The derivatives in $PB_n(z^{\#})$ are computed holding the rule $\mathrm{k}^{\#}(\cdot|z^{\#})$ fixed (i.e., without differentiating the term $\gamma^{\#}(z^{\#})$). The derivatives in $SB_n(z^{\#})$ are computed holding the rule $\mathrm{k}^{**}(\cdot|z^{\#})$ fixed (i.e., without differentiating the term $\gamma^{**}(z^{\#})$).

First observe that

$$\frac{\partial}{\partial z_n}Var\left[\tilde{k}^{j}-\tilde{K}\mid z^{\#}\right]=\left(\kappa_1\gamma^{\#}(z^{\#})\right)^{2}\frac{\partial}{\partial z_n}Var\left(\sum_{s=1}^{N}\lambda_s(z^{\#})\tilde{\xi}_s^{j}\right).$$

Because

$$\frac{\partial}{\partial z_n} Var\left(\sum_{s=1}^{N} \lambda_s(z^\#)\tilde{\xi}_s^j\right) = \frac{\partial}{\partial z_n}\left[\sum_{s=1}^{N} \frac{\left(\lambda_s(z^\#)\right)^2}{t_s z_s^\#}\right] = \sum_{s=1}^{N} \frac{2\lambda_s(z^\#)}{t_s z_s^\#}\frac{\partial \lambda_s(z^\#)}{\partial z_n} - \frac{\left(\lambda_n(z^\#)\right)^2}{t_n\left(z_n^\#\right)^2},$$

and because, for any $s = 1, ..., N$, $t_s z_s^\# = \pi_s(z^\#)/(1-\rho_s(z^\#))$, I have that

$$\frac{\partial}{\partial z_n} Var\left[\tilde{k}^j - \tilde{K} \mid z^\#\right] = \left(\kappa_1 \gamma^\#(z^\#)\right)^2 \left[\sum_{s=1}^{N} \frac{2\left(1-\rho_s(z^\#)\right)\lambda_s(z^\#)}{\pi_s(z^\#)}\frac{\partial \lambda_s(z^\#)}{\partial z_n} - \frac{\left(\lambda_n(z^\#)\right)^2}{t_n\left(z_n^\#\right)^2}\right].$$

Next, observe that

$$\begin{aligned}
&\frac{\partial}{\partial z_n} Var\left[\tilde{K} - \tilde{\kappa} \mid z^\#\right] \qquad (80)\\
&= \frac{\partial}{\partial z_n} Var\left[\kappa_1\left(\gamma^\#(z^\#) - 1\right)\tilde{\theta} + \kappa_1 \gamma^\#(z^\#)\sum_{s=1}^{N} \lambda_s(z^\#)\tilde{\varepsilon}_s \;\middle|\; z^\#\right]\\
&= \left(\kappa_1 \gamma^\#(z^\#)\right)^2 \frac{\partial}{\partial z_n} Var\left[\sum_{s=1}^{N} \lambda_s(z^\#)\tilde{\varepsilon}_s \;\middle|\; z^\#\right]\\
&= \left(\kappa_1 \gamma^\#(z^\#)\right)^2 \frac{\partial}{\partial z_n}\left[\sum_{s=1}^{N} \left(\lambda_s(z^\#)\right)^2 \frac{1}{\eta_s}\right]\\
&= \left(\kappa_1 \gamma^\#(z)\right)^2 \left\{\sum_{s=1}^{N}\left(2\lambda_s(z^\#)\frac{\partial \lambda_s(z^\#)}{\partial z_n}\right)\frac{1}{\eta_s}\right\}.
\end{aligned}$$

Because, for any $s = 1, ..., N$, $\eta_s = \pi_s(z^\#)/\rho_s(z^\#)$, I thus have that

$$\frac{\partial}{\partial z_n} Var\left[\tilde{K} - \tilde{\kappa} \mid z^\#\right] = \left(\kappa_1 \gamma^\#(z^\#)\right)^2 \sum_{s=1}^{N} \frac{2\rho_s(z^\#)\lambda_s(z^\#)}{\pi_s(z^\#)}\frac{\partial \lambda_s(z^\#)}{\partial z_n}.$$

The same steps imply that

$$\frac{\partial}{\partial z_n} Var^{**}\left[\tilde{k}^{j*} - \tilde{K} \mid z^\#\right] = \left(\kappa_1^* \gamma^{**}(z^\#)\right)^2 \left[\sum_{s=1}^{N} \frac{2\left(1-\rho_s(z^\#)\right)\lambda_s(z^\#)}{\pi_s(z^\#)}\frac{\partial \lambda_s(z^\#)}{\partial z_n} - \frac{\left(\lambda_n(z^\#)\right)^2}{t_n\left(z_n^\#\right)^2}\right]$$

and

$$\frac{\partial}{\partial z_n} Var^{**}\left[\tilde{K} - \tilde{\kappa} \mid z^\#\right] = \left(\kappa_1^* \gamma^{**}(z^\#)\right)^2 \sum_{s=1}^{N} \frac{2\rho_s(z^\#)\lambda_s(z^\#)}{\pi_s(z^\#)}\frac{\partial \lambda_s(z^\#)}{\partial z_n}.$$

Note that the last two expressions are obtained by recognizing that the efficient strategy $k^{**}(\cdot; z^\#)$ has the same structure as the equilibrium strategy $k^\#(\cdot; z^\#)$, with $(\kappa_0^*, \kappa_1^*)$ replacing $(\kappa_0, \kappa_1)$, and $\gamma^{**}$ replacing $\gamma^\#$. Hence,

$$PB_n(z^\#) = |u_{kk}|\left(\kappa_1 \gamma^\#(z^\#)\right)^2 \left\{\frac{\left(\lambda_n(z^\#)\right)^2}{2t_n\left(z_n^\#\right)^2} - \sum_{s=1}^{N} \frac{(1-\alpha\rho_s(z^\#))\lambda_s(z^\#)}{\pi_s(z^\#)}\frac{\partial \lambda_s(z^\#)}{\partial z_n}\right\}$$

and

$$SB_n(z^\#) = |u_{kk} + u_{\sigma\sigma}|\left(\kappa_1^* \gamma^{**}(z^\#)\right)^2 \left\{\frac{\left(\lambda_n(z^\#)\right)^2}{2t_n\left(z_n^\#\right)^2} - \sum_{s=1}^{N} \frac{(1-\alpha^*\rho_s(z^\#))\lambda_s(z^\#)}{\pi_s(z^\#)}\frac{\partial \lambda_s(z^\#)}{\partial z_n}\right\}.$$

In the proof of Proposition 6, I established that, when the weights in the statistic $X^j$ are those in (57),

$$\frac{\left(\lambda_n(z^\#)\right)^2}{2t_n\left(z_n^\#\right)^2} - \sum_{s=1}^{N} \frac{(1-\alpha\rho_s(z^\#))\lambda_s(z^\#)}{\pi_s(z^\#)}\frac{\partial \lambda_s(z^\#)}{\partial z_n} = \frac{\left(\pi_n(z^\#)\right)^2\left\{\frac{1}{2} - \frac{1-\alpha\rho_n(z^\#)}{1-\beta\alpha\rho_n(z^\#)} + \frac{\sum_{s=1}^{N}\frac{\pi_s(z^\#)\left(1-\alpha\rho_s(z^\#)\right)}{\left(1-\beta\alpha\rho_s(z^\#)\right)^2}}{\sum_{l=1}^{N}\frac{\pi_l(z^\#)}{1-\beta\alpha\rho_l(z^\#)}}\right\}}{\left(\sum_{l=1}^{N}\frac{\pi_l(z^\#)}{1-\beta\alpha\rho_l(z^\#)}\right)^2 t_n\left(z_n^\#\right)^2\left(1-\beta\alpha\rho_n(z^\#)\right)^2}.$$

When $\beta = 0$, the above expression reduces to

$$\frac{\left(\pi_n(z^\#)\right)^2\left[\frac{1}{2}+\alpha\left(\rho_n(z^\#)-\rho_X(z^\#)\right)\right]}{\left(\pi_X(z^\#)\right)^2 t_n\left(z_n^\#\right)^2}.$$

I thus have that

$$PB_n(z^\#)=|u_{kk}|\left(\kappa_1\gamma^\#(z^\#)\right)^2\left\{\frac{\left(\pi_n(z^\#)\right)^2\left[\frac{1}{2}+\alpha\left(\rho_n(z^\#)-\rho_X(z^\#)\right)\right]}{\left(\pi_X(z^\#)\right)^2 t_n\left(z_n^\#\right)^2}\right\}. \tag{81}$$

Similarly,

$$SB_n(z^\#)=|u_{kk}+u_{\sigma\sigma}|\left(\kappa_1^*\gamma^{**}(z^\#)\right)^2\left\{\frac{\left(\pi_n(z^\#)\right)^2\left[\frac{1}{2}+\alpha^*\left(\rho_n(z^\#)-\rho_X(z^\#)\right)\right]}{\left(\pi_X(z^\#)\right)^2 t_n\left(z_n^\#\right)^2}\right\}. \tag{82}$$

Note that $1/2+\alpha\left(\rho_n(z^\#)-\rho_X(z^\#)\right)$ is necessarily positive because, for any source that receives strictly positive attention in equilibrium, necessarily $PB_n(z^\#)>0$.

**Part (a)**. Consider economies in which $\kappa_1=\kappa_1^*$ and $\alpha=\alpha^*$. Because the term in curly bracket in $PB_n(z^\#)$ and $SB_n(z^\#)$ is positive and $\gamma^\#(z^\#)=\gamma^{**}(z^\#)$, I conclude that, starting from $z^\#$, having the agents pay more attention to a source $n$ that receives strictly positive attention in equilibrium (i.e., for which $z_n^\#>0$) increases welfare if $u_{\sigma\sigma}<0$ and decreases it if $u_{\sigma\sigma}>0$.

**Part (b)**. Next, consider economies in which $u_{\sigma\sigma}=0$, and $\alpha=\alpha^*$. Again, because $\gamma^\#(z^\#)=\gamma^{**}(z^\#)$, I conclude that, starting from $z^\#$, having the agents pay more attention to a source $n$ that receives strictly positive attention in equilibrium (i.e., for which $z_n^\#>0$) and then use the information efficiently (i.e., according to the rule $\mathrm{k}^{**}(\cdot;z^\#)$) increases welfare if $|\kappa_1^*|>|\kappa_1|$ and decreases it if $|\kappa_1^*|<|\kappa_1|$. Q.E.D.

**Proof of Proposition 8.** In the proof of Proposition 7, I established that the private and social (gross) marginal benefits of increasing the attention to any source $n$, starting from the attention $z^\#$ in the unique symmetric equilibrium with bounded recall, are equal to (81) and (82), respectively. Specializing these expressions to the class of economies under consideration, I have that, when $\kappa_1=\kappa_1^*$ and $u_{\sigma\sigma}=0$,

$$SB_n(z^\#)-PB_n(z^\#)\overset{\text{sgn}}{=}Q(z^\#,\alpha,\alpha^*)+\left[\alpha^*\left(\gamma^{**}(z^\#)\right)^2-\alpha\left(\gamma^\#(z^\#)\right)^2\right]\rho_n(z^\#),$$

where

$$Q(z^\#,\alpha,\alpha^*)\equiv\left(\gamma^{**}(z^\#)\right)^2\left[\frac{1}{2}-\alpha^*\rho_X(z^\#)\right]-\left(\gamma^\#(z^\#)\right)^2\left[\frac{1}{2}-\alpha\rho_X(z^\#)\right].$$

The result in the proposition then follows by observing that (i) $Q$ is the same across all sources of information, (ii) when $\alpha\left(\gamma^\#(z^\#)\right)^2>\alpha^*\left(\gamma^{**}(z^\#)\right)^2$, $SB_n(z^\#)-PB_n(z^\#)$ is decreasing in $\rho_n$, whereas the opposite is true when $\alpha\left(\gamma^\#(z^\#)\right)^2<\alpha^*\left(\gamma^{**}(z^\#)\right)^2$. Finally note that, when $\pi_\theta\to 0$, $\gamma^\#(z^\#),\gamma^{**}(z^\#)\to 1$, in which case $Q\to(\alpha-\alpha^*)\rho_X(z^\#)$, implying that $\bar\rho\to\rho_X(z^\#)$. Q.E.D.

## Appendix A. Supplementary material

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jet.2025.106013.

## Data availability

No data was used for the research described in the article.

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