Can Media Pluralism Be Harmful to News Quality?

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Motivation

- The Internet facilitates pluralism in information but empirical evidence suggests a deterioration of the quality of the information (Allcott and Gentzkow, 2017).
- Research question: when is media pluralism beneficial to news consumers?
- Theoretical model with three main ingredients:
  - Biased news sources (McCarthy and Dolfsma, 2014)
  - Unbiased news consumers with heterogeneous beliefs (Hirsch, 2016)
  - Limited attention by news consumers (Pew Research Center, 2020)

$\Longrightarrow$ sufficient conditions for media pluralism to be harmful.

Model

- $\Omega = \{\omega_1, \omega_2\}$, $A = \{a_1, a_2\}$ and $S = \{s, s'\}$ are, respectively, the set of states, the set of actions and the set of messages.
- There are two types of agents: experts (media) and decision-makers (news consumers).
- Each agent I has a prior belief $\mu_I^0(\omega_1) \in (0, 1)$.
- Bayesian Persuasion model. Literature Review
  - Commitment power: the interpretation of messages is objective.

Experts

- Each expert $j \in J$ (he) has a preferred action $a_j \in A$ and his payoff from a decision-maker who takes action $a \in A$ is:

$$u_j(a, \omega) = u_j(a) = \mathbb{1}\{a = a_j\} \quad \text{for any state } \omega \in \Omega$$

- Each expert designs information to manipulate decision-makers' behaviour:
  - The expert j chooses a reporting policy $\pi_j : \Omega \to \Delta(S)$.
  - He commits to the probability $\pi_j(s \mid \omega)$ to send message s given state ω, for any message $s \in S$ and any state $\omega \in \Omega$.

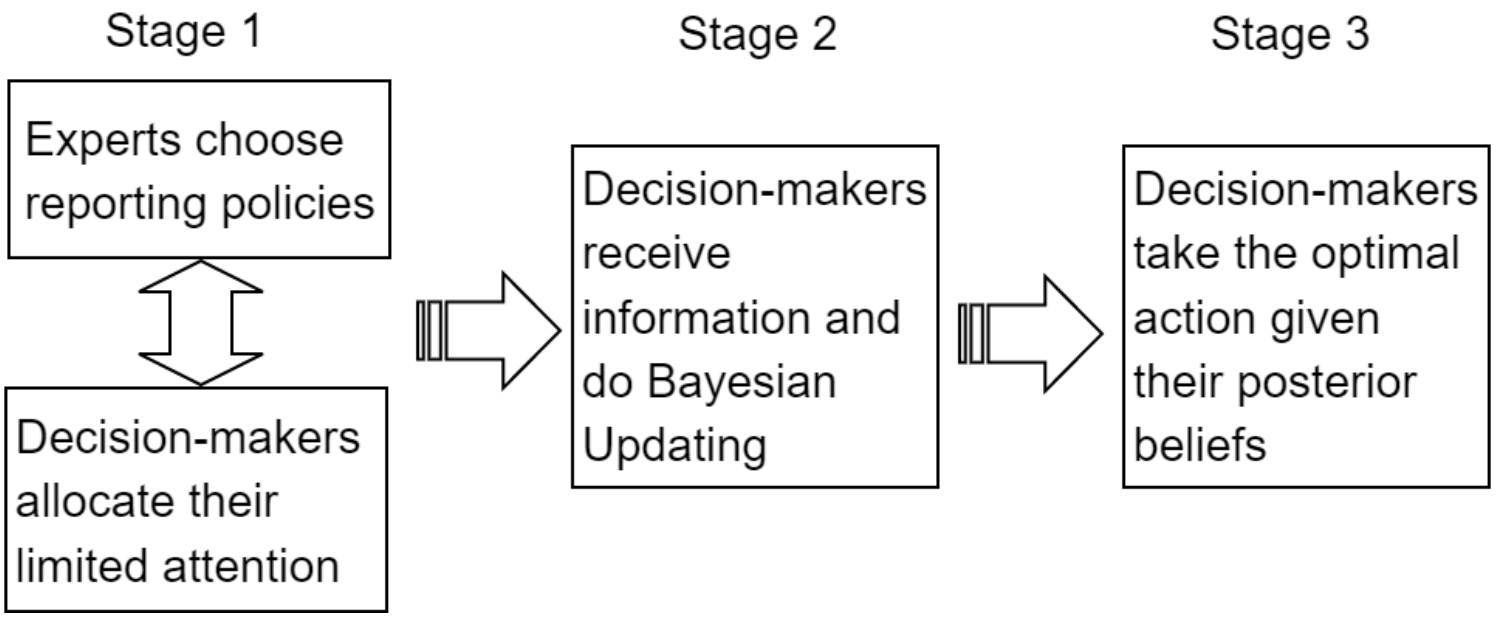
Decision-makers

- D is the set of decision-makers, who are partitioned in two homogenous subgroups: those in subgroup i share the same prior belief $\mu_i^0(\omega_1)$ for each $i \in \{1, 2\}$.
- Each decision-maker (she) takes an action $a \in A$. Her goal is to match the action with the state:

$$u(a, \omega_k) = \mathbb{1}\{a = a_k\} \quad \text{for any } k = 1, 2.$$

- Before taking an action, each decision-maker $d \in D$ pays attention to one expert $j_d \in J$:
  - She uses the information provided by the expert to update her belief.

Timing



Evidence

Road map

1. Focus on the problem of one expert $\Longrightarrow$ Benchmark: Monopoly
2. Analysis of the whole game $\Longrightarrow$ Media pluralism

Benchmark: Monopoly

- Assume that the preferred action of the expert is a_1. The *persuasion constraints* are:

$$\pi(s \mid \omega_2) \leq \frac{\mu_i^0(\omega_1)}{\mu_i^0(\omega_2)} \pi(s \mid \omega_1) = \phi_i \pi(s \mid \omega_1)$$

- Without information (or in case of babbling),
  - Believers ($i = 1$, $\phi_1 > 1$) choose the expert's preferred action a_1.
  - Sceptics ($i = 2$, $\phi_2 < 1$) choose the expert's undesired action a_2.

- The expert designs informative messages to change sceptics' behaviour but all decision-makers receive the same information $\Longrightarrow$ believers' behaviour could change.

- Trade-off between persuading sceptics and retaining believers $\Longrightarrow$ two candidates for the optimal policy: the *hard-news policy* and the *soft-news policy*.

Optimal policy

- The hard-news policy focuses on persuading sceptics.
  - Message s must be credible i.e., misleading only to a limited extent.
  - With positive probability the expert reveals his unfavourable state (message s') $\implies$ believers take the expert's undesired action.
- The soft-news policy focuses on retaining believers.
  - The expert sends two messages of different credibility.
  - Message s is credible enough to persuade sceptics. Message s' is not, but does not induce believers to take the expert's undesired action $\implies$ the expert leverages believers' credulity.
- Hard-news policy more informative than soft-news policy (Blackwell, 1953). Nevertheless, the expert prefers the soft-news policy if:
  1. Decision-makers have sufficiently polarized beliefs; ⏩ Graph
  2. The expert's unfavourable state is sufficiently likely from his perspective.

Media pluralism

- Two experts with different preferred actions:
  - Expert α: preferred action a_1, Believers $i = 1$ and Sceptics $i = 2$.
  - Expert β: preferred action a_2, Believers $i = 2$ and Sceptics $i = 1$.
- Simultaneous-moves game: Optimal information design by experts **AND** endogenous allocation of attention by decision-makers.
- Each expert j chooses π_j to maximize the probability that decision-makers take a_j, given his audience $H_j = \{d \in D \,|\, j_d = j\}$.
- Given the policies of the experts, each decision-maker d of subgroup i allocates her attention to maximize her subjective probability of taking the correct action: $j_d \in \arg\max_{j \in J} \lambda_i(\pi_j)$.

Equilibrium preliminaries

- It holds that $\lambda_i(\pi_j) \in [\mu_i^0(\omega_m), 1]$, where m is the most plausible state given prior belief.
- Receiving information is always (weakly) beneficial:
  - An expert can change the behaviour of rational decision-makers ...
  - ... but has to provide credible information, and this makes decision-makers (weakly) better off.

  $\implies$ (weakly) positive subjective information gain from persuasion: $\Delta_{ij} = \lambda_i(\pi_j) - \mu_i^0(\omega_m) \geq 0$
- Targeted decision-makers: a persuading message makes them just indifferent between the two actions (binding persuasion constraint)
- Subgroup i is the target of expert $j \implies \Delta_{ij} = 0$.

Echo Chambers

- Strategic tension: each decision-maker wants to avoid being a target, whereas each expert has (at least) one target.
- Echo chambers (audience = believers) arise endogenously as an equilibrium outcome.
  - Babbling is the optimal policy for each expert.
  - Given babbling, decision-makers have no incentive to deviate.
- Lower information quality and (weakly) lower information gains for any decision-maker, compared to monopoly.
  - A monopolist uses either his hard-news policy or his soft-news policy.
  - These policies produce some dispersion in posterior beliefs, whereas babbling leaves beliefs unchanged.

Symmetric Equilibrium

- An equilibrium is "symmetric" if any two decision-makers of the same subgroup i pay attention to the same expert j.
- Echo chambers is the unique symmetric equilibrium where both experts are active.
- Opposite-bias learning (audience = sceptics) is not an equilibrium.
  - Each expert uses his hard-news policy.
  - Sceptics have zero information gains, but hypothetical believers would have positive information gains.
  - Sceptics have incentive to deviate and become believers of the other expert.
- There exists also "asymmetric" equilibria. Details

Harmful Media Pluralism

- For any equilibrium, there exists a monopoly outcome such that for any decision-maker:
  1. Information gain is (weakly) higher;
  2. Information quality is (weakly) higher.

- Robust result:
  - Continuous distribution of beliefs; Details
  - Costly attention; Details
  - Partial commitment; Details
  - Non-Bayesian persuasion; Details
  - Attention adjustment cost; Details
  - Entropy cost; Details
  - Attention-concerned experts; Details
  - Continuous state space; Details
  - More than two experts. Details

Policy implications

- Increasing media pluralism has a non-monotonic effect on information quality.
  - Media pluralism backfires when attention becomes limited.
  - Endogenous allocation of attention $\Longrightarrow$ decision-makers cluster into echo chambers $\Longrightarrow$ the incentives for experts to provide valuable information vanish.
- Echo chambers can arise even with unbiased news consumers.
  - Rational foundation of confirmation bias (no intrinsic preference, equilibrium outcome).
- Open question: is the formation of echo chambers mainly demand-driven or supply-driven?
  - Necessary to design policy remedies.

Thank you for your (limited) attention!

Contributions to the literature

- Bayesian Persuasion: Kamenica and Gentzkow (2011).
  - Competition with unlimited attention: Gentzkow and Kamenica (2017);
  - Competition where media want to gather attention: Knoepfle (2020).
- Echo Chambers:
  - Cheap talk with biased news consumers: Jann and Schottmuller (2021).
  - Non-strategic media: Martinez and Tenev (2020).

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Evidence: attention habits

- Eisensee and Strömberg (2007): Politicians' reporting about natural disasters respond strategically to attention habits.
- Ciampaglia et al. (2015): Attention towards specific issues stimulates the supply of Wikipedia articles about that issues.

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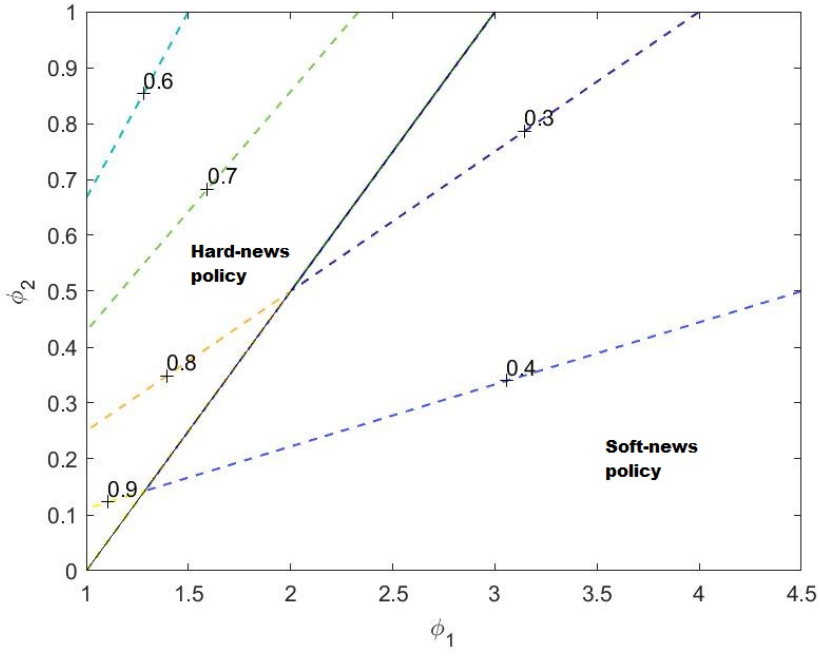
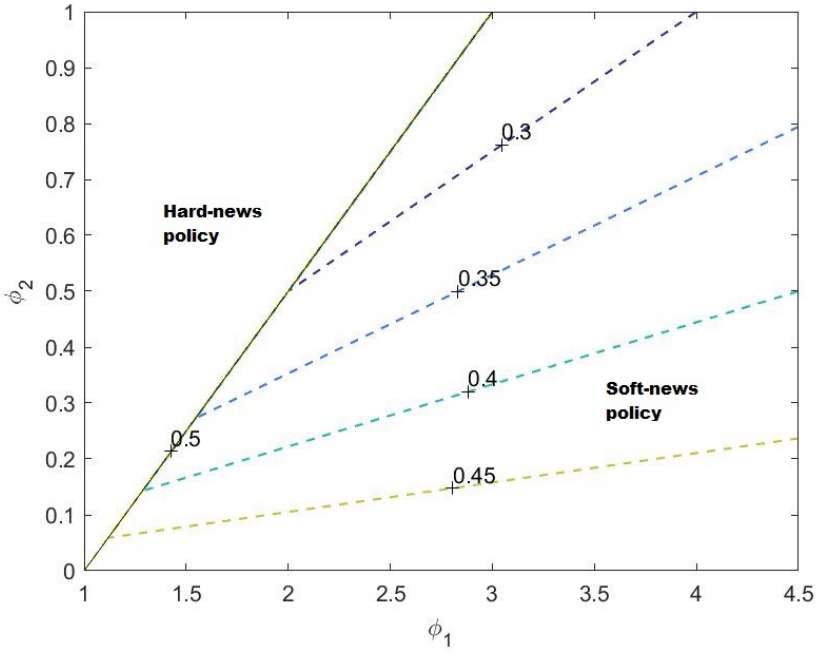
Information quality



(a) Believers



(b) Sceptics

Figure: Range of posterior beliefs when $\mu^0(\omega_1) = \frac{1}{2}$ and $g_1 = \frac{1}{2}$.

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"Asymmetric" equilibria

- Necessary condition: decision-makers of the same subgroup are indifferent about the allocation of attention.
- Asymmetric equilibria with one informative expert and one babbling expert.
  - The babbling expert must collect attention only from his believers.
- Asymmetric equilibria where each expert uses his soft-news policy.
  - All decision-makers are targets of each expert $\implies \Delta_{ij} = 0$ for any i and any j.
  - Any allocation of attention that makes it optimal for each expert to use his soft-news policy constitutes an equilibrium.

Set of equilibria

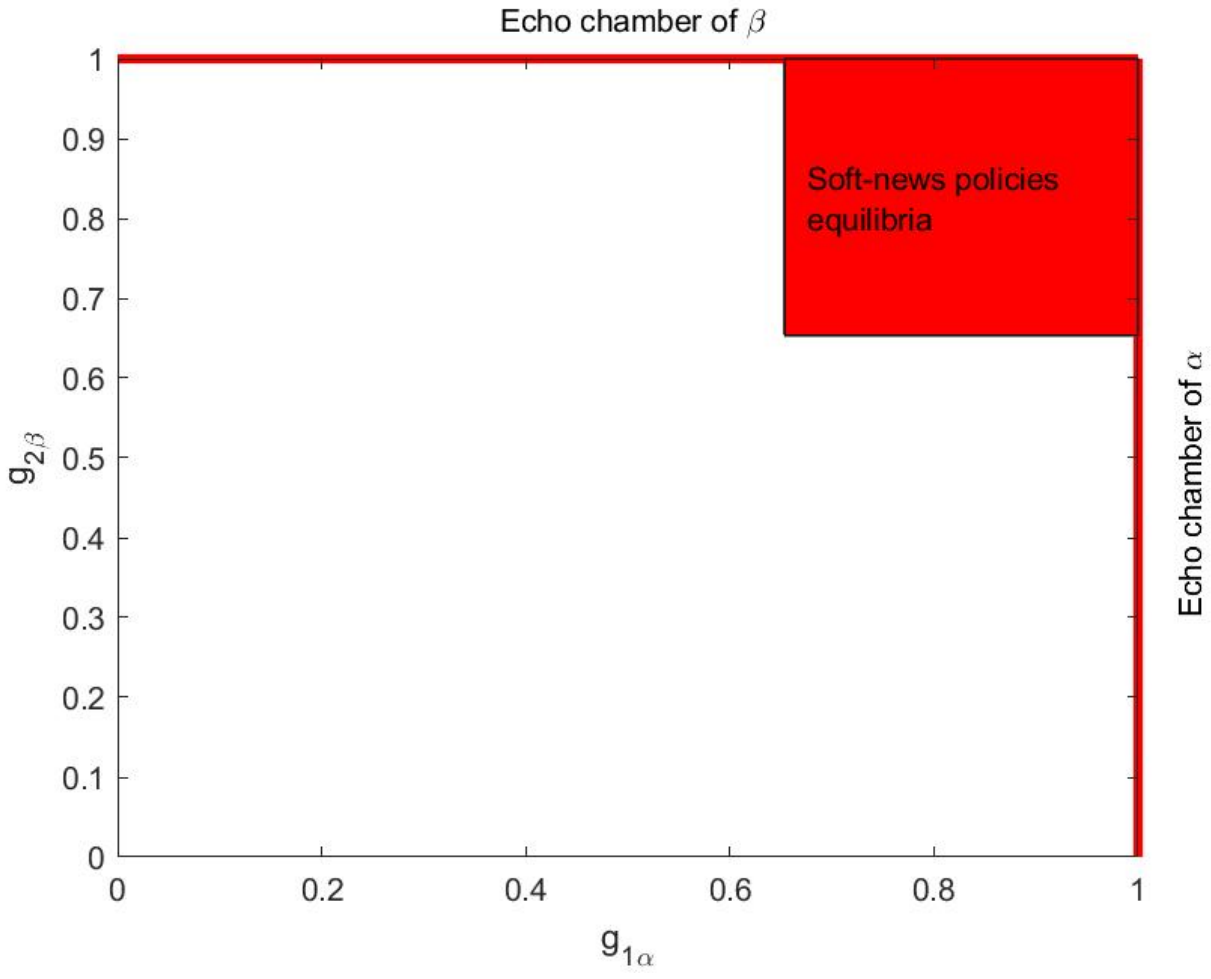

Figure: Allocations of attention that can support an equilibrium, when $\mu_\alpha^0(\omega_1) = \mu_\beta^0(\omega_2) = \frac{7}{10}$, $\phi_1 = 2$ and $\phi_2 = \frac{1}{2}$.

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Continuous distribution of beliefs

- In a monopoly, the optimal policy is either a hard-news policy or a soft-news policy.
- The monopolist uses a hard-news policy if $\phi \in [0, 1]$ solves

$$h(\phi) = \frac{1}{\phi_j + \phi}$$

where $h(\cdot)$ is the hazard rate function. Graph

- Media pluralism with limited attention:
  1. Any symmetric equilibrium has at most one informative expert.
  2. *Partial echo chambers*: those believers with the most extreme prior beliefs join the echo chamber of the babbling expert.
  3. For any equilibrium, there exists a monopoly outcome such that for any decision-maker information gain and information quality are (weakly) higher.

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Costly attention

- Each decision-maker can devote attention to a second expert at a cost $c \geq 0$.
- Full revelation is an equilibrium if and only if $c = 0$.
  - $\lambda_i(\pi_\alpha) = \lambda_i(\pi_\beta) = \lambda_i(\pi_J) = 1$ for any $i \in I$.
  - If $c > 0$, each decision-maker strictly prefers to devote attention to one expert $\implies$ truth-telling is not optimal for the experts.
- Multi-homing is not optimal because at most one expert is informative.
  - Assume α is informative whereas β is babbling.
  - For any $i \in H_\alpha$, it holds $\lambda_i(\pi_\alpha) = \lambda_i(\pi_J)$ because π_β does not affects posterior beliefs, hence optimal actions.
  - For any $i \in H_\beta$ it must be the case that both experts are providing zero information gains, and $\lambda_i(\pi_\alpha) = \lambda_i(\pi_\beta) = \lambda_i(\pi_J) = \mu_i^0(\omega_m)$.

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Partial commitment

- With probability $\delta \in (0,1)$ the expert can deviate from his reporting policy $\Longrightarrow$ Babbling.
- This changes the persuasion constraints. Two effects:
  - Persuasion of sceptics is possible only if $\phi_i \geq \delta$.
  - A targeted sceptic has a positive information gain.
- The equilibria which rely on targeted sceptics being indifferent about the allocation of attention (i.e., the asymmetric equilibria) do not exist with partial commitment.
- Instead, the symmetric equilibria (echo chambers and partial echo chambers) are robust to this extension.
  - Even if targeted sceptics have a positive information gain, they still have incentives to become believers of the other expert.

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Non-Bayesian persuasion

- Generalized version of the persuasion constraint (de Clippel and Zhang, 2020):

$$\pi(s \mid \omega_2) \leq \phi_i^{\rho} \pi(s \mid \omega_1) = \hat{\phi}_i \pi(s \mid \omega_1) \tag{1}$$

- When $\rho \in (0,1)$, decision-makers are subject to base-rate neglect or over-inference $\implies$ distribution of $\hat{\phi}_i$ more moderate.

- When $\rho > 1$, decision-makers overweight priors or are subject to under-inference $\implies$ distribution of $\hat{\phi}_i$ more extreme.

- $\hat{\phi}_i$ is relevant for the expert's information design, whereas decision-makers keep evaluating information based on their priors.
  - If $\rho \in (0,1)$, targeted sceptics have a negative information gain $\implies$ the unique equilibrium of the game is echo chambers.
  - When $\rho > 1$, the targeted sceptics have a positive information gain, but still have incentives to become believers of the other expert.

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Attention adjustment cost

- Decision-makers can adjust their allocation of attention at a cost $\zeta \geq 0$, after the reporting policies have been settled.
- Full revelation is the equilibrium if and only if $\zeta = 0$.
  - Full revelation requires all decision-makers to be second-movers.
  - At the same time, given full revelation, a decision-maker is not willing to pay a positive cost to be a second-mover.
- Echo chambers are robust if ζ is large enough.
  - Expert α can attract second-movers of subgroup i only if $\zeta \leq \lambda_i(\pi_\alpha) - \lambda_i(\pi_\beta)$.
  - In particular, expert α can attract his sceptics $i = 2$ as second-movers if $\lambda_2(\pi_\alpha) \geq \mu_2^0(\omega_2) + \zeta$.
  - Therefore, a sufficient condition for the robustness of echo chambers is $\zeta > \mu_2^0(\omega_1) \implies$ the higher polarization, the lower the threshold of ζ for echo chambers to be robust.

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Entropy cost

- Information is costly either to process for decision-makers (Matysková and Montes, 2021) or to produce for experts (Gentzkow and Kamenica, 2014).
- In the first case, echo chambers is the unique equilibrium.
  - A decision-maker prefers receiving babbling than being a target.
  - This can be interpreted as a form of confirmation bias: news consumers bear a cognitive cost when they change their beliefs.
  - Any arbitrary confirmation bias makes echo chambers the unique robust equilibrium.
- In the second case, the optimal policies change but experts keep targeting decision-makers (unless information is so costly that babbling is the best option).
  - Same equilibria but lower quality of information.
  - Nevertheless, the negative effect of media pluralism on quality continues to exist.

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Attention-concerned experts

- Experts are biased but also care of gathering attention.
- The payoff of expert j from a decision-maker who takes action $a \in A$ and devotes attention to expert $j_d \in J$ is:

$$u_j(a, j_d) = \mathbb{1}\{a = a_j\} + \gamma \mathbb{1}\{j_d = j\}$$

- Each expert is better off the larger is his audience, but this does not affect his reporting policies because he take as given his audience.

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Continuous state space

- Continuous state space i.e. $\Omega = [0, 1]$ keeping the action binary i.e. $A = \{a_0, a_1\}$.
- Each decision-maker wants to take action a_1 if and only if the state ω is above a threshold $\bar{\omega}$.
- The structure of the optimal policy changes, but experts continue to target some decision-makers.
- The latter experiences zero information gain: incentives are the same as in the baseline model.

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More than two experts

- The entry of experts with the same preferences and belief as the incumbent is not affecting information provision.
  - The entrant cannot refine the optimal policy of the incumbent.
- With limited attention, two experts using the same policy can be active $\Longrightarrow$ experts split attention, but no qualitative effect on results.
  - If the experts use different policies, then decision-makers have incentive to devote attention to the most informative one.

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