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Abstract

Conventional wisdom suggests that competition in the modern digital environment pushes media outlets toward the early release of less accurate information. We show that this is not necessarily the case. We argue that two opposing forces determine the resolution of the speed-accuracy tradeoff: preemption and reputation. More competitive environments may be more conducive to reputation building, which may lead to better reporting. However, the audience may be worse off due to the outlets' better initial information. Finally, we show how a source may exploit the speed-accuracy tradeoff to quickly get "unverified facts" out to the audience.

Keywords: media competition, preemption, reputation

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1 Introduction

On April 18, 2013, the *New York Post* plastered its cover page with a picture of two men under the headline "BAG MEN: Feds seek these two pictured at Boston Marathon." The Post was hinting that the duo was responsible for the Boston Marathon bombings and had carried the bombs in their bags. They were innocent, and the Post was wrong. 16-year-old Salaheddin Barhoum and 24-year-old Yassine Zaimi later filed a lawsuit, and the New York Post's credibility was damaged. Similarly, in September 2008, *Bloomberg* incorrectly reported that United Airlines was filing for bankruptcy. Before Bloomberg issued a correction, United Airlines' stock price nosedived 75 percent.

Media critics often cite such examples to argue that competitive pressures in the modern digital environment have pushed outlets towards the early release of less accurate information (Cairncross, 2019).[1] Matt Murray, Editor-in-Chief of the *Wall Street Journal*, acknowledged in a recent interview that the Internet had created both time and competitive pressures. However, part of the pressure, he noted, "is to stay true to what has worked and works (really) well, which is reporting verified facts." In a similar vein, some media scholars argue that the fears surrounding the effect of competition may be overblown (Knobel, 2018; Carson, 2019).

In this paper, we discuss why competition among media outlets might not privilege speed over accuracy. We also consider the implications of competition on audience welfare and information dissemination. We argue that two opposing forces determine the resolution of the speed-accuracy tradeoff: preemption and reputation. While preemption pushes outlets towards speed, reputation gives media outlets a reason to engage in careful, detailed reporting.

[1]Such pressures towards speed-driven journalism are a cause of concern for modern democracies. Media outlets, through fact-checking and investigative journalism, deliver revelations that have a profound impact on society and its institutions. For instance, *The Hindu*'s Bofors scam exposé in India in 1987 brought the topic of political corruption to center stage and lead to the defeat of the government in power in 1989. More recently, the *New York Times*' exposé on sexual abuse in Hollywood and corporate America has reignited discussions on gender discrimination in the workplace.

We build a two-period model in which two career-concerned media outlets compete against one another and fear preemption. There is a topic on which the outlets may publish stories. Both outlets receive an initial informative signal about the topic. They may research the topic further at a cost that depends upon their ability. We model research as generating a perfectly-informative signal about the topic. There is a scoop value associated with being the first outlet to publish a story on the topic. In addition to valuing scoops, outlets also care about their reputations, which depends upon an audience's inference about the outlet's ability to research.

Our model yields three main results. The first two speak to the changes in the media landscape brought about by the Internet. The last result deals with how a source disseminates information to media outlets facing the speed-accuracy tradeoff.

The Internet has reduced barriers to entry and contributed to a 24-hour news cycle where reporters are always on deadline. Consequently, the competitive pressures on media outlets have increased. We argue that while competition can push media outlets to publish more quickly, it can also have the opposite effect – to push outlets to research stories more thoroughly. We find that it is easier for outlets to build a reputation in more competitive environments, increasing their willingness to hold back and research stories thoroughly. Significantly, our argument relies upon the assumption that the audience does not observe the amount of time outlets spend researching stories, but they do observe which outlet publishes first. Knowing the sequence of publications rather than the amount of research allows for additional observational learning in a competitive environment. Consequently, it gives better outlets a reason to differentiate when facing competition.

We show that when there is a high scoop value, competition drives media outlets to publish more quickly; in contrast, when there is a low scoop value, competition drives media outlets to research stories more. Therefore, the model suggests that breaking news-type stories, such as those on terrorist attacks, malfeasance of senior government officials, or adverse economic shocks, will suffer particularly from accuracy problems in the Internet age. In contrast, outlets do better research on non-urgent stories that do not influence immediate decision-making. Examples may include revelations of sexual abuse by Hollywood executives, how terrorist organizations work, and illegal data hacking used to influence public opinion.[2]

A second effect of the Internet has been to improve what quickly-released stories look like. Journalists can quickly access sources and data by "contacting people, accessing government records, filing Freedom of Information Act requests, and doing searches" (Chan, 2014; Knobel, 2018). At the same time, however, the cost of doing in-depth research has not changed much. For instance, one would not expect the cost of conducting interviews and building trustworthy sources to have changed significantly. We model such an effect as improving the quality of the initial signal without changing the cost of research.

We find that a *better* initial signal can *reduce* the welfare of the audience. When the initial signal becomes better, the audience is less able to attribute correct information by the media outlets to their ability to conduct in-depth research. Thus, reputational concerns get diluted and timing pressures become more salient, making the media outlets move towards speed. If the audience values better reporting sufficiently, speed-driven journalism can reduce welfare.

Lastly, our model also shows how a politically-motivated source can share rumors with competing outlets to get "unverified facts" out to the audience. Our critical insight here is that such a source may not necessarily share the rumor with both outlets. Indeed, when the audience does not view the story as urgent, sharing the rumor with just one outlet may be better to get the news out quickly.

Contributions to related literature. The speed-accuracy tradeoff is commonly

[2]The first story was published in both the *New York Times* and the *New Yorker*. The second story appeared on the *New York Times* following more than a year-and-a-half's research. The third story broke out in *The Guardian*.

recognized in the media studies literature.[3] The literature highlights two critical determinants of the rise of "speed-driven journalism" in the modern digital environment – increasing competitive pressures (Rosenberg and Feldman, 2008) and 24-hour news cycles (Lee, 2014; Starbird, Dailey, Mohamed, Lee, and Spiro, 2018), both of which increase preemption risks. Importantly, however, reputational concerns remain relevant. Knobel (2018) summarizes her interviews with the editors by saying that they realize that readers can be induced to pay for quality journalism.[4]

The newsroom dilemma, however, is surprisingly understudied in media economics despite agreement among media scholars on its importance. We primarily contribute by explicitly modeling the newsroom dilemma and determining its effect on the quality of news when reputation matters and it is endogenously determined.[5]

Relevant exceptions are Shahanaghi (2021b) and Shahanaghi (2021a). The former provides a microfoundation for the speed-accuracy trade-off in a dynamic model of learning and reporting where the sender is concerned about its reputation. The latter applies that framework in a competitive setting showing that competition exacerbates, through preemption motives, an already existent incentive to misreport. Our model has a different structure in terms of information arrival – discrete, finite time and correlated signals – and observability of time by the readership that leads to a different prediction in terms of the effects of competition: its additional informational content can, sometimes, increase the quality of the output.

Few other papers like Lin (2014), Andreottola and De Moragas (2021) and Oliver

[3]The BBC Academy website observes that "every journalist has to resolve the conflicting demands of speed and accuracy. [...] If you are working on a breaking news story, it is important to remember that first reports may often be confused and misleading. [...] That is why it is important to weigh the facts you have."

[4]She quotes Rex Smith, editor of the *Albany Times Union*, "What can separate great journalism from everything else is our commitment to the journalism of verification and watchdog reporting. It will give us credibility that other organizations do not have." See Appendix F for a summary of Knobel (2018)'s results and how it relates to our findings.

[5]Andina-Díaz, García-Martínez, and Parravano (2019) studies how a market of non-strategic outlets competing for scoops evolves depending on how harshly society punishes the publication of false stories. In our case, both outlets and the readership are strategic players.

(2022) study the speed-accuracy trade-off but do so typically in different contexts and without explicitly endogenizing the effects on reputation. Our approach is different as we consider a preemption game where competition plays a direct role, and any effect on reputation is endogenously determined by Bayesian updating in equilibrium.

Focusing more on reputation-building and signaling in media markets, Gentzkow and Shapiro (2006) model media bias and reputation building, showing that competition reduces bias. The model explores an entirely different tradeoff looking at the content of the reporting directly rather than the timing. Gentzkow and Shapiro (2008) later outline a model that may incorporate reputation-building incentives like ours, but they do not consider preemption. Shapiro (2016) shows that reputational concern for unbiasedness may induce journalists to report evidence as ambiguous even when it is not. Preemption concerns and endogenous choice of research are not considered there.[6]

We also contribute to the literature on strategic information release. We differentiate from Guttman (2010) and Guttman, Kremer, and Skrzypacz (2014) by adding reputational concerns and endogenizing the information acquisition choice. Therefore, our results are driven by entirely different incentives. Relatedly, Aghamolla (2016) looks at a model of (anti-)herding between financial analysts with observational learning and endogenous information acquisition. Observational learning is relevant only for the audience in our model because it signals the type of outlet.

Finally, by adding reputational concerns, we contribute to the literature on preemption games and R&D races. Preemption games have long been studied in economics (Fudenberg and Tirole, 1985), but our paper contributes to the more recent literature on preemption games with private information (Hopenhayn and Squintani, 2011, 2015; Bobtcheff, Bolte, and Mariotti, 2016). It is worth noting that Bobtcheff et al. (2016)

[6] Our modelling strategy shares some features with Hafer, Landa, and Le Bihan (2018, 2019). Like us, they have a two-period model where competing outlets can acquire information about a politically relevant state of the world and choose when to release it. However, we do not focus on media bias and the possibility of claiming credit for a story but rather on the trade-off between time pressure and the quality of journalism. See Prat and Strömberg (2013) and Strömberg (2015) for recent developments in the political economy of media literature, and other related papers.

have a similar "separating" result for different types of firms, but in a setup without reputation. Here we point out that reputation, combined with actions that partially reveal an opponent's type, can be a different force leading to separating strategies in preemption games.

2 A model of the newsroom dilemma

We build a simple two-period model indexed by $t = 1, 2$ featuring three players: two strategic media outlets i, j and a fixed mass of audiences. We also consider a version with just one media outlet.

State of the world. The state of the world ω is binary and unknown to the players. Formally, $\omega \in \Omega := \{a, b\}$ with common prior $\Pr(\omega = a) = \frac{1}{2}$. Ω pertains to the topic on which the media outlets are digging a story and the relevant information for the audience. This could be, for instance, who is responsible for a terrorist attack, whether a senior government official is involved in corruption or not, who is an appropriate candidate to vote for in the election, etc.

Media outlets. Initially, each outlet privately observes a signal s^i about the state of the world in $t = 1$. We call this the story that the outlets have. We assume that s^i is free and i.i.d. conditional on the state. Its precision is $\Pr(s = \omega|\omega) = \pi > \frac{1}{2}$. Outlet i's decision d^i at $t = 1$ is to choose between publishing immediately in $t = 1$, *pub*, or doing more research and then publishing in $t = 2$, *res*. The two outlets make their decisions simultaneously.

Publishing is equivalent to endorsing a particular state of the world (independent of whether published in $t = 1$ or 2). When an outlet publishes its story, it sends a message $m^i \in M = \{a, b\}$ where each message is understood as endorsing that particular state.

Conducting further research is costly. In particular, there is a type-specific cost of research that perfectly reveals the true state of the world in $t = 2$. Outlets can be of two types, high or low, depending on how efficient they are at digging into stories, and this is the private information of each individual outlet. Formally, the type of outlet i is $\theta^i \in \{h, l\}$ with a common prior $\Pr(\theta^i = h) = q = \frac{1}{2}$.[7] The types are independent.

$\theta = l$ faces an infinite cost of conducting research. The low outlet never digs stories further and chooses $d = pub$ in $t = 1$. The cost c for the high outlet is private information of that outlet and is story-specific. It comes from a uniform distribution F with support $[-\varepsilon, \bar{c}]$ and is drawn independently for each high outlet. ε is greater than zero but small to capture the idea that some high outlets may still want to conduct research even in the absence of other rewards.[8] We assume $\bar{c} \geq 2$ so that the support of the distribution F is sufficiently large.

Audience. The audience enters the game when one or both of the outlets publish their story. They only rationally form beliefs about the types of outlets. They enter with the knowledge of the priors and an understanding of the competition between the outlets. Other than this, the precise information of the audience at the time of belief formation is denoted by the set $\mathcal{I}$.

We assume that the audience observes the sequence of publication but not the actual time of publication, or whether the outlets conducted research. The sequence is denoted by $\tilde{t}^i \in \{\text{I}, \text{II}, \varnothing\}$, which shows whether outlet i was first, second, or it moved simultaneously with j. This assumption is discussed in more detail in Section 2.2, and its implications are described in the main analysis in Section 3.

In addition, after both outlets publish their stories, the state is revealed exogenously. If $m^i = \omega$, then outlet i is said to be right, or R. Otherwise, the outlet is wrong, denoted by W. We call this the outcome O of verification. The audience sees the outcome.

[7] The assumption on q is just for analytic convenience. A generic $q \in (0, 1)$ does not qualitatively alter the results. We show this case in Appendix D.

[8] Interviews with editors often confirm such motivations; often they feel a sense of responsibility in their positions. For instance, Knobel quotes Marcus Brauchli, *Washington Post*'s former editor, "Doing investigative journalism is in the *Post*'s DNA and has been as long as any of us have been around in journalism." Similarly, Kevin Riley, the Editor of the *Atlanta Journal-Constitution* explains, "People want us to do this. They don't think anyone else will if we don't."

Therefore, the information of the audience $\mathcal{I}$ at the end of the game is denoted by a tuple $(O^i_{\tilde{t}}, O^j_{\tilde{t}})$ that consists of four pieces of information, i.e., the position of each outlet in the sequence of publication and their outcomes. Using $\mathcal{I}$, the audience updates its beliefs about each outlet's type. Denote the posterior belief about $\theta = h$ by $\gamma(\mathcal{I})$ when the information held by the audience is $\mathcal{I}$.

Payoffs. The outlets' payoffs are composed of three elements.

1. The first is a scoop value v, which is the benefit to the first outlet publishing the story. It captures the preemptive nature of the media market (Besley and Prat, 2006). One may interpret it as the advertising revenue associated with the audience that is drawn to the first media outlet breaking the story.

2. The second is a reputation value of γ^i or the audience's posterior on the quality of outlet i calculated after the revelation of the true state. This captures the extent to which the outlets care about their reputation. For instance, the future audience of the outlets and the advertising revenue they bring might depend on their reputations. We assume that reputation enters linearly in the outlets' payoffs.[9]

3. The third is the cost c that the high-type outlet chooses to pay if it does research.

We currently refrain from defining the audience payoffs as they only form beliefs. However, microfoundations are provided later in Section 4.

Timing. The timing of the game can now be summarized as follows:

0. Nature draws ω, θ^i and θ^j. θ is privately observed by each outlet. ω is unobserved.

1. At $t = 1$ each outlet privately observes s^i. A cost c of digging into the story is drawn from a uniform distribution $F[-\varepsilon, \bar{c}]$ for the high type.

[9]Note that the audience cares about whether the outlet is high or low type, not about c. A new c is drawn for every new story, and only the high type has the ability to conduct further research.

2. The outlets simultaneously decide $d^i \in \{pub, res\}$ and if $d^i = pub$ then also choose m. As stated before, this is a relevant decision only for the high type. The low type always chooses *pub*.

3. If both outlets publish, the game ends. Otherwise, the game goes to period 2.

4. At $t = 2$, the state is revealed to every outlet that chose $d^i = res$. Those who did not publish in $t = 1$, publish now by choosing m.

5. Once both outlets have published, the state ω is revealed to the audience. They observe $\mathcal{I}$ and update beliefs on the type of each outlet. Payoffs are realized.

2.1 Solution concept and equilibria selection

The solution concept we use is the Perfect Bayesian Nash Equilibrium in pure strategies. We focus on equilibria where outlets optimally follow the signal they receive, i.e, they endorse the state that is more likely to be the true one given their signal. We call such equilibria *signal-based* equilibria.[10] For the rest of the paper, we use "equilibrium" and "signal-based equilibrium" interchangeably.

2.2 Discussion of assumptions

The first assumption we make is regarding what the audience observes about the timing of the game. The fact that the audience only observes the content of what was published and the sequence of publication captures the idea that it is unaware of how much the outlets researched the story. We believe this is a realistic assumption in that the amount of research is hardly observable from outside the newsroom. Consequentially, player i's decision to publish or not potentially conveys information about player j's

[10]This means that we ignore equilibria where outlets choose to endorse one particular state to signal their type. Those equilibria may exist, but we argue that they do not make much sense given the environment we are considering. Alternatively, we can assume that signals are hard information, but the reader cannot infer the level of precision: the result would be exactly the same.

type. For example, if the two outlets move sequentially and only a high type is expected to conduct research, moving later is a signal of the first outlet being a low type. We show how relaxing this assumption changes our result in Section 3.4.

The second assumption we make is about who possesses stories on a topic. In reality, competing media outlets are often unaware of whether their competitors are also exploring the same story. We assume that both of the media outlets are aware that their competitor also possesses the story. Doing so pushes the incentives of the outlets the most towards speed and keeps our model tractable. Still, we show that more research is possible under competition.

The third assumption we make is that outlets build a reputation on their consistent types, and not on the cost of digging into each independent story. As outlets usually have different "expertise", it is reasonable to assume that they face different costs when exploring different stories. For instance, *The Wall Street Journal* is a business-centric daily and has invested in building sources and methods for dealing with business stories (such as avoiding lawsuits when potentially sensitive corporate information is published). However, in general, some outlets have a culture of research while others do not. Our notion of type captures such a culture.

We also make a few assumptions for tractability reasons. First, we do not allow for the outlets to "sit on information" or wait for a period before publishing.[11] Second, we assume that the audience correctly finds out the state at the end of the game. Third, we assume that the media outlet correctly finds out the state upon choosing to research. Almost all of these assumptions can be relaxed to some degree without altering our predictions.

2.3 Preliminary observations and strategies

We start with a few simplifying observations. All the proofs are in Appendix A.

[11] We show in Appendix C that for a sufficiently high v and relevant off-path beliefs, the outlets never choose to wait.

Observation 1 *Suppose there are reputational gains in matching the state. If an outlet decides to publish in $t = 1$, it follows its signal s, i.e., sends $m = s$. If an outlet decides to do research and then publish in $t = 2$, it follows the outcome of the research.*

Observation 1 follows from the fact that in $t = 1$, the most informative signal is s. Therefore, the most likely state is the one given by the signal. Moreover, in $t = 2$, the outlet choosing to research has learned the actual state and publishes it. Thus, as long as there is a gain in matching the state, each outlet follows its last signal, which is also the most informative.

There is also a helpful result arising from our particular signal structure and flat priors.

Lemma 1 *If each outlet follows its last signal when publishing, then (1) the probability of matching the state after only s is π, and (2) regardless of whether i decides to publish or research, from its point of view, the expected probability of player j matching the state without research is π.*

Lemma 1 will help write the incentive compatibility conditions for the players. Doing so will require each outlet to consider whether the other will do research and the subsequent probability of matching the state.

It is useful to define the strategies we will focus our attention on. First, the only relevant and meaningful decision is one of the high-type outlets in period 1. From the outlet's point of view, there is a threshold on cost, c_D, such that it researches only if the realized cost is below it.[12] From the other outlet's (and the audience's) point of view, define σ^i, the conjectured probability that outlet i chooses to research further in $t = 1$,

[12] Subscript D represents the case of a two-firm duopoly. Similarly, we represent a single-firm monopoly case with subscript M.

conditional on outlet i being a high type. Therefore,

$$\sigma^i = \Pr(c \leq c_D) = F(c_D) = \begin{cases} 0 & c_D < -\varepsilon \\ \frac{c_D+\varepsilon}{\bar{c}+\varepsilon} & -\varepsilon \leq c_D \leq \bar{c} \\ 1 & c_D > \bar{c} \end{cases}$$

We are now ready to move to the equilibrium analysis in different market configurations.

3 Competition leads to better reporting

3.1 Newsroom dilemma with a single firm: Monopoly

We start with the simplest case: there is a single media outlet, and its type is known.

Proposition 1 *If there is one media outlet and its type is known to the audience, then the high outlet conducts research with probability* $F(0) = \frac{\varepsilon}{\bar{c}+\varepsilon}$.

In this case, none of the above incentives are at play, neither preemption nor reputation. The outlet is driven to research only because of its intrinsic motivation.

The case of monopoly with unknown type is more interesting.

Proposition 2 *If there is one media outlet and its type is not known to the audience, there exists a unique equilibrium in which the high outlet conducts research if and only if* $c \leq (1-\pi)(\gamma(R;\sigma^*) - \gamma(W;\sigma^*)) := c_M(\sigma^*)$. *As a consequence,* $\sigma^* = F(c_M(\sigma^*)) = \frac{c_M(\sigma^*)+\varepsilon}{\bar{c}+\varepsilon}$.

Begin by noting that preemption risk is absent in this case; v does not play any role. Proposition 2 then captures the idea that c_M is defined so that the expected reputational gains from endorsing the correct state more than compensates the additional cost c of doing research. To see these reputational gains, suppose that the high outlet is expected to research with probability σ. The audience only observes whether the outlet is right (R) or wrong (W); there is no sequence to observe. Therefore, the two relevant belief updates are

$$\gamma(R;\sigma) = \frac{\sigma + (1-\sigma)\pi}{\sigma + (1-\sigma)\pi + \pi} \text{ and } \gamma(W;\sigma) = \frac{(1-\sigma)(1-\pi)}{(1-\sigma)(1-\pi) + (1-\pi)} = \frac{1-\sigma}{2-\sigma}$$

from Bayes' rule. The cost threshold, $c_M(\sigma)$, then shows that the reputational gains, $\gamma(R;\sigma) - \gamma(W;\sigma)$, arise only if doing research helps match the state. Since this was already happening with probability π by not researching, the additional benefits of doing research occur with probability $1-\pi$.

Note that the equilibrium σ, σ^*, is the solution to the fixed point equation $\sigma^* = F(c_M(\sigma^*)) = \frac{c_M(\sigma^*)+\varepsilon}{\bar{c}+\varepsilon}$. Proposition 2 further shows that such a fixed point exists and is unique.

3.2 Newsroom dilemma with two firms: Duopoly

The main effect of the competition is the introduction of preemption risk. When preemption is relevant, and reputation building is not, the equilibrium where the high outlet conducts research becomes even rarer than in Proposition 1. Notably, if the scoop value is sufficiently small relative to the intrinsic motivation, i.e., if $v < 2\varepsilon$, there will still be some high outlets willing to investigate. Proposition 3 below highlights these altered incentives.

Proposition 3 *If there are two media outlets and their types are known to the audience, there exists a unique symmetric equilibrium in which the high outlets conduct research with probability* $\sigma_D^* = F\left(-\frac{v}{2}\right)$.

The case of competition with unknown types is the most interesting one. In this case, both preemption risk and reputation-building concerns simultaneously interact.

Proposition 4, below captures these two effects in the new cost threshold, c_D.

Proposition 4 *If there are two media outlets and their types are not known to the audience, there exists a unique and symmetric equilibrium where the probability that a high outlet conducts research is* $\sigma^{i*} = \sigma^{j*} := \sigma^* = F(c_D(\sigma^*))$ *such that*

$$c_D(\sigma^*) = \frac{1}{2}\left[(\gamma(\varnothing;\sigma^*) - \gamma(1;\sigma^*))\left(\sigma^* - (2-\sigma^*)\pi^2\right) + 1\right] - \frac{1}{2}\upsilon$$

where $\gamma(\varnothing) = \frac{(\sigma^*)^2+(1-\sigma^*)(2-\sigma^*)\pi^2}{(\sigma^*)^2+(2-\sigma^*)^2\pi^2}$ *and* $\gamma(1) = \frac{1-\sigma^*}{2-\sigma^*}$.

Recall that the audience observes both the outcome of verification $\mathcal{O} \in \{R, W\}$ and the sequence of publication $\tilde{t} \in \{\text{I}, \text{II}, \varnothing\}$ for both i and j. So, for a given conjectured level of σ^i and σ^j, the relevant audience's on-path beliefs need to be defined for the following events:

$$(R_\varnothing, R_\varnothing), (R_\varnothing, W_\varnothing), (W_\varnothing, W_\varnothing), (W_\varnothing, R_\varnothing), (R_\text{I}, R_\text{II}), (W_\text{I}, R_\text{II}), (R_\text{II}, R_\text{I}), (R_\text{II}, W_\text{I}),$$

where the first outcome-sequence element in each information set is outlet i's and the second is outlet j's.[13]

Three belief updates can summarize these eight events.

1. *No information about timing:* When both outlets get the state correct and publish simultaneously, the audience cannot determine the publication timing. It cannot distinguish between them conducting research, i.e., both are high types with low costs or publishing immediately. The latter happens because both are low types, or because there is only one high type and it faces a high cost, or because both are high types but face high costs. With some abuse of notation, we denote the

[13]Note that it never happens that an outlet moves second in the sequence and gets the state incorrect. Any outlet that moves second has conducted research and matches the state perfectly. Therefore, any event with W_II does not occur on-path.

updated belief here by $\gamma(\varnothing; \sigma_i, \sigma_j)$ so that,

$$\gamma^i(R_\varnothing, R_\varnothing) = \frac{\sigma^i\sigma^j + (1-\sigma^i)(2-\sigma^j)\pi^2}{\sigma^i\sigma^j + (2-\sigma^i)(2-\sigma^j)\pi^2} := \gamma^i(\varnothing; \sigma_i, \sigma_j).$$

2. *Published in period 1 without research:* In the events $\{(R_\varnothing, W_\varnothing), (W_\varnothing, W_\varnothing), (W_\varnothing, R_\varnothing), (R_{\text{I}}, R_{\text{II}}), (W_{\text{I}}, R_{\text{II}})\}$ the audience is able to determine that outlet i moved in the first period without research. Specifically, the presence of a competitor who gets the state wrong when both publish simultaneously or a competitor who moves second conveys that the outlet under consideration did not research. Here the only uncertainty for the audience is whether the outlet is a high type that faces a high cost or a low type. We denote the updated belief by $\gamma^i(1; \sigma_i)$ in these events and it equals $\frac{1-\sigma^i}{2-\sigma^i}$.

3. *Published in period 2 after research:* If outlet i moves second and gets the state right, the audience understands that such an outlet is high type. Thus, $\gamma^i(R_{\text{II}}, R_{\text{I}}) = \gamma^i(R_{\text{II}}, W_{\text{I}}) = 1 := \gamma^i(2)$.

Using these updated beliefs, a high outlet's incentive compatibility can be written as $c^i \leq c^i_D(\sigma_i, \sigma_j)$, where

$$c^i_D(\sigma_i, \sigma_j) \equiv \underbrace{\frac{1}{2}\left[\sigma^j\left(\gamma^i(\varnothing) - \gamma^i(1)\right) + (2-\sigma^j)\left(1 - \pi^2\gamma^i(\varnothing) - (1-\pi^2)\gamma^i(1)\right)\right]}_{\text{net reputational gains}} - \underbrace{\frac{1}{2}v}_{\substack{\text{preemption}\\ \text{loss}}}$$

To understand c^i_D, we can break down the various components of the net reputational gain. First, $\frac{1}{2}\sigma^j(\gamma^i(\varnothing) - \gamma^i(1))$ captures the gain of researching when j does research as well, which happens with probability $\frac{1}{2}\sigma^j$. Here, outlet i benefits by increasing its reputation from $\gamma^i(1)$ to $\gamma^i(\varnothing)$. Second, $\frac{1}{2}(2-\sigma^j)(1 - \pi^2\gamma^i(\varnothing) - (1-\pi^2)\gamma^i(1))$ is the gain of researching when j does not research, which happens with probability $\frac{1}{2}(2-\sigma^j)$. Now, the benefit of inducing a belief of 1 is weighed against the loss of inducing a belief of $\gamma^i(\varnothing)$ if the two would have matched the state by not researching, which happens with probability π^2, and that of inducing a belief of $\gamma^i(1)$ if either would have gotten the state wrong, which happens with the complement probability.

As before, the cost threshold $c_D(.)$ is endogenous to the conjectured strategies σ_i and σ_j. In equilibrium, it is required that both σ_i and σ_j are solutions to the fixed point equations $\sigma_i = F(c_D(\sigma_i, \sigma_j))$ and $\sigma_j = F(c_D(\sigma_i, \sigma_j))$. Proposition 4 then follows.

3.3 Competition may lead to better reporting

The comparison between monopoly and duopoly when reputation building is relevant (Propositions 2 and 4) provides interesting insights.

Lemma 2 *The reputational gains are always higher in a duopoly than in a monopoly.*

The reason lies in the availability of additional information in the duopoly case. The audience's ability to separate the outlet that publishes second and matches the state correctly allows it to confer a higher reputation. In turn, this makes the outlet i more willing to pay the cost of research. However, the additional preemption concerns in duopoly counterbalance this positive information effect and makes c_D decrease in v (see Proposition 4). The two effects combined yield our first main result about the effect of Internet-driven competition on reporting.

Proposition 5 *There exists a nonempty interval of scoop values, v, where $\sigma_D^* > \sigma_M^*$.*

Proposition 5 says that there is a non-empty set of parameters where research is more likely in a duopoly than in a monopoly. Therefore, competition may lead to better reporting. We illustrate this result in Figure 1. The orange line is $F(c_D)$, the green line is $F(c_M)$, and the blue one is the 45° line. The equilibrium probability of research is given by the point of intersection of $F_c(c_D)$ and $F_c(c_M)$ with the 45° line. Increasing v parallelly lowers the orange line without affecting the green line. It is clear that $\sigma_D^* > \sigma_M^*$ for sufficiently small v.

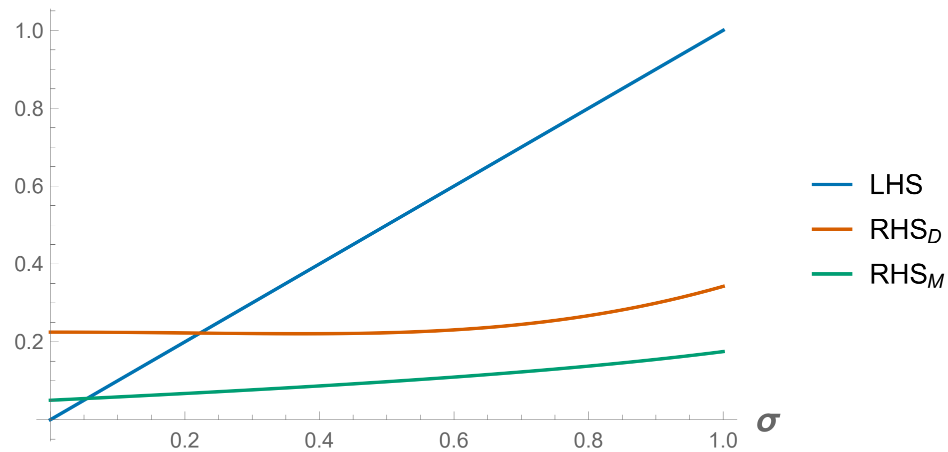

Figure 1: Equilibrium σ_D^* and σ_M^* for when $\pi = .6$, $v = .3$, $\bar{c} = 2$ and $\varepsilon = .1$

The main point of Proposition 5 is that, contrary to the wisdom of the crowd in media studies literature, competition does not necessarily lead to a faster release of less accurate information.[14]

3.4 The role of audience's information

The previous results relied critically on what the audience observes from the competition, or simply the "transparency". To build further intuition, we analyze how changing transparency affects our results. Consider the two other possibilities – nothing about the timing is observable, and the timing of research is fully observable. Our original assumption lies in the middle of this increasing transparency spectrum. Of course, the publication's content is always visible to the audience, i.e., the audience observes m.

Unobservable timing or zero transparency. Without any information on timing or sequence, the audience consumes the content of the outlet publishing the story, considering each outlet separately. The behavior of the monopolist is exactly as before. Hence, $c_M = (1-\pi)(\gamma(R) - \gamma(W))$ does not change. In a duopoly, however, the

[14]In Drago, Nannicini, and Sobbrio (2014), the authors empirically show a positive effect of new newspaper outlet entry on voter turnout in municipal elections, the reelection probability of the incumbent mayor, and the efficiency of the municipal government using Italian municipal elections data between 1993-2010. While not direct evidence of our results, more information that the voters get with more outlets can drive the result in their paper.

endorsement of the other outlet does not matter anymore in the updating. Therefore, $\gamma(R,.) = \gamma(R)$ and $\gamma(W,.) = \gamma(W)$.

Corollary 1 *If neither time nor the sequence of publication is observable, the cost threshold, c'_D, of a high outlet in a duopoly is $c'_D = c_M - \frac{1}{2}v$, and therefore, $c'_D < c_M$ for every strictly positive scoop value v.*

Intuitively, there are no additional reputational gains because one cannot "look good" in the presence of a competitor. But the additional risk of preemption pushes c_D down.

Observable timing or full transparency. If the timing of publication is observable, a high-type monopolist can fully differentiate itself by conducting research and publishing in period 2. Moreover, this is true in duopoly as well. The actual content of the publication does not matter for reputation-building, and differentiation is driven entirely by the timing. Consequently, there is no additional learning in the duopoly, but preemption concerns reduce the incentives to investigate and conduct research.

Corollary 2 *If the timing of publication is observable, the cost thresholds, c''_M and c''_D, for a high outlet in a monopoly and a duopoly, respectively are $c''_M = 1 - \gamma(1)$ and $c''_D = 1 - \gamma(1) - \frac{1}{2}v$, where $\gamma(1) = \frac{1-\sigma}{2-\sigma}$. Therefore, $c''_D < c''_M$ for every strictly positive scoop value v.*

Note that the cost thresholds are now larger than in the previous information environments due to the maximum distinction between outlets moving in two time periods. Therefore, the actual levels of reputational benefits are also higher. Notably, there is no belief update like $\gamma(\varnothing)$.

It is worth emphasizing that these extreme transparency assumptions do not fit our environment well - completely unobservable timing clashes with the idea of the preemptive nature of the media market. If the audience does not understand when the publication happened, there is nothing to gain from being first. This is not true in reality. On the other hand, perfectly observable timing implies that the reader understands precisely how much research went into an article. Therefore, the whole differentiation happens on the time dimension rather than on the story's truthfulness. Again, this hardly seems true in reality.

4 Stories and the effect of better initial information

We are now in a position to discuss the kinds of stories that are more or less susceptible to speed-driven journalism. To do so, we place more restrictions on audience preferences.

Let there be a unit mass of audience. The audience decides whether to take a given action or not. Let this action be denoted by $\alpha \in \{a, b\}$ and interpreted as "matching the state". The audience seeks out the information published by the outlets and consumes its content to the extent it wants to match its action to the story. Examples include decisions on who to vote for or to form opinions.

For any given story, a fraction u of the audience requires the information urgently, and the remaining $1 - u$ is patient. The preferences of the urgent audience are given by

$$V_u = \begin{cases} 1 \text{ if deciding today and } \alpha = \omega, \\ 0 \text{ if deciding today and } \alpha \neq \omega, \\ -k \text{ if remaining undecided or deciding tomorrow,} \end{cases}$$

where "today" happens for the audience when the first outlet publishes its content. The preference of the patient audience, on the other hand, is given by

$$V_{1-u} = \begin{cases} 1 \text{ if } \alpha = \omega, \\ -k \text{ if } \alpha \neq \omega, \\ 0 \text{ if remaining undecided.} \end{cases}$$

The patient audience does not care about when it makes the decision; making an accurate decision matters more. So, for k sufficiently large (assume so), the patient audience does not consume any content if outlets publish simultaneously as it is unsure whether the story has been researched. In such cases, only a fraction u of the audience consumes the content. On the other hand, it matters more to the urgent audience to make a decision as soon as the first outlet publishes. Thus, when outlets publish sequentially, a fraction u of the audience consumes the first publication, and $1-u$ consumes the second. We further assume that the entire audience mass is available for reputation-building.

u is story-specific, and when the outlets get a story they also learn perfectly the value of u. The idea is that those stories with a relatively high u are more urgent than others. These could include, for example, information about whether a company has gone bankrupt, whether the authorities caught the terrorists, etc. Therefore, u is akin to v, or the scoop value from the previous analysis.

We begin by noting that the monopoly case discussed in Proposition 2 remains unchanged. The result of the duopoly case also remains qualitatively unchanged, albeit with a new cost threshold, $\bar{c}_D$, in the symmetric equilibrium, $\bar{\sigma}^* = F(\bar{c}_D(\sigma^*))$. The precise expressions of these objects are presented in Appendix B.

An increase in the fraction of urgent audience u still reduces $\bar{c}_D$ and decreases $\bar{\sigma}^*$. Therefore, a high fraction of the urgent audience for a story pushes the outlets towards speed. The next proposition compares the probabilities of research in the no-competition monopoly case with the duopoly case on the basis of u.

Proposition 6 *There exists a fraction of urgent audience, $\bar{u} \in (0,1)$ such that*

- *for stories with at most $\bar{u}$ fraction of urgent audience, research by high outlets in a duopoly is at least as likely as in monopoly, i.e., $\bar{\sigma}_D \geq \sigma_M$, and*

- *for stories with more than $\bar{u}$ fraction of urgent audience, research by high outlets* *in a duopoly is less likely than in monopoly, i.e.,* $\bar{\sigma}_D < \sigma_M$.

We, therefore, hypothesize that competitive environments are better for research on non-urgent topics. One such example is the recent *New York Times* exposé on sexual abuse in Hollywood. It is reasonable to believe that sexual abuse by an influential movie producer does not directly impact the decision-making of a large fraction of society. Yet, it was an important finding that will have a long-run impact as women come forward and demand justice, and organizations respond. On the flip side, investigations and research on urgent topics are less likely in competitive environments. The example of terrorist attacks fits perfectly in this setting. In fact, after the Boston Marathon bombing in April 2013, there was much confusion in the media, and articles were published without fact-checking.

We can now also make assessments about the audience's welfare.[15] The audience's welfare V is defined as follows

$$V = \left[\left(\frac{1}{2}\right)^2 + 2\frac{1}{4}(1-\bar{\sigma}^*) + \left(\frac{1}{2}\right)^2(1-\bar{\sigma}^*)^2\right]\pi u + \\ + 2\frac{1}{4}\bar{\sigma}^*\left[1+(1-\bar{\sigma}^*)\right](1-u+\pi u) + \left(\frac{1}{2}\right)^2(\bar{\sigma}^*)^2 u$$

The first term is the probability that the two outlets move together but do not research. As a result, the probability of matching the state is π, and only a fraction u of the audience gets this payoff. The second term is the probability that the outlets move sequentially, in which case the fraction $1-u$ matches the state, but fraction u only matches it with probability π. Finally, the third is when both outlets move together after researching the story. In this case, they match the state perfectly but fraction $1-u$ does not receive this payoff.

As discussed in Section 1, another important effect of the Internet has been to make

[15] Note that even if the audience knows that outlets may be publishing without research, it is still better to listen to the outlets rather than follow the priors in decision-making.

it easier to conduct preliminary research. Emails and social media make it particularly easy to share pictures, videos, and text from any part of the world. One way to interpret it is as an increase in π, the precision of the outlets' initial signal. This effect, Knobel (2018) argues, should lead to better reporting. We show below that that is not necessarily true. Our next proposition shows that the overall effect of an increase in π on the audience welfare is dependent on the kind of story u being explored.

Proposition 7 *There exists an interior u, $\bar{u}^V \in (0,1)$, such that if the story has less than $\bar{u}^V$ fraction of urgent audience, an increase in precision π of initial signal s decreases the overall welfare V.*

The intuition for this somewhat surprising result is straightforward. The equilibrium probability of research falls as precision π increases because a more precise initial signal reduces the reputational gain that comes with separation. The audience attributes correctly matching the state more to technology-driven better initial information rather than actual research. Preemption concerns, therefore, become more salient and push the outlets toward speed. In turn, it hurts the average audience if it is composed of more patient types, i.e., u is low.

5 Information dissemination by a source

We now turn back to our original model and use it to determine how a source can share her signal with media outlets. In general, a strategic source's preferences may be summarized by the following objective function,

$$\mathbb{1}\{\text{publication in } t = 1\} + \mu \text{Pr}(\text{matching the state}),$$

where the parameter $\mu \geq 0$ captures the weight that the source places on accurate information from at least one outlet *vis-à-vis* having at least one outlet publishing in period 1. For instance, a concerned citizen or an employee in a firm witnessing some wrongdoing might have a high preference for accuracy. On the flip side, a politically-motivated source who merely wants to get some potentially incorrect information out quickly will have a low preference for accuracy.

Our aim is to determine whether the source wants to share her signal with one or both the outlets to fulfill her objective.[16]

First, we make a simple observation that follows from our analysis of monopoly and duopoly. In what follows, we drop the star notation for convenience with an understanding that we are talking about equilibrium values.

Corollary 3 *The equilibrium probability of research by a high outlet in monopoly is* $\sigma_M > 0$ *while in duopoly is* $\sigma_D \geq 0$.

Corollary 3 is an important one. It highlights that while in a monopoly the probability of research is always positive; in a duopoly, it might be zero if v is sufficiently high. This corollary will help us outline the behavior of a source who is aware of the scoop value v associated with her story.

Second, we write down the expected utility of the source for the equilibrium research probabilities that will be induced in the following subgame. The expected payoff from sharing the story with one outlet is

$$\frac{1}{2}(1+\mu\pi)+\frac{1}{2}[\sigma_M\mu+(1-\sigma_M)(1+\mu\pi)], \tag{1}$$

[16]In line with our model, we will assume that if the source shares a story with both of the outlets, both are aware that the other also possesses the same story. Therefore, the information is shared "publicly". But when the source shares the signal with just one outlet, we will assume that the other is unaware and the former outlet knows so. This assumption allows the outlet with a story to effectively behave as a monopolist from our analysis in Section 3.1. We also assume that the source possesses a story of a fixed precision π. She makes her decision about who to share the story with at the beginning of the game before time 0. The type of the outlet is still each outlet's private information; the source does not have this information when making her decision.

while from sharing with both outlets is

$$\begin{aligned} &\frac{1}{4}(1+\mu\pi) + \frac{1}{4}[1+\mu(\sigma_D + (1-\sigma_D)\pi)]2+ \\ &\qquad + \frac{1}{4}[(1-\sigma_D)^2(1+\mu\pi) + 2\sigma_D(1-\sigma_D)(1+\mu) + \sigma_D^2\mu]. \end{aligned} \tag{2}$$

The following lemma helps simplify the source's optimal response for a given σ_M and σ_D.

Lemma 3 *The source's best response can be summarized as follows:*

- *The source prefers to share the story with both the outlets unambiguously for any* $\mu \geq 0$ *if* $\frac{\sigma_D^2}{2} \leq \sigma_M \leq \frac{\sigma_D(4-\sigma_D)}{2}$.
- *Otherwise, the source prefers to share the story with both (one) outlets if* $\mu(1-\pi)(2\sigma_M - \sigma_D(4-\sigma_D)) \leq (>) 2\sigma_M - \sigma_D^2$.

The lemma shows that there is a range of equilibrium σ_M and σ_D for which the source always prefers to send information to both the outlets independent of μ. Interestingly, this region lies around the $\sigma_D = \sigma_M$ line. Therefore, the lemma shows that for σ_M and σ_D close to each other, there is reason to prefer both outlets. To understand why let us break this down into two further statements.

First, there are parameters where one outlet alone is more likely to research than when it is competing with another, i.e., $\sigma_M > \sigma_D$ and μ is very large, and yet the source prefers to share the story with two outlets. Doing so makes sense for the source because the total probability of research from sharing the story both outlets is *larger* than when shared with one. When shared with one it is equal to $\frac{1}{2}\sigma_M$. When shared with both it is given by $\frac{1}{4}[\sigma_D^2 + 2\sigma_D(1-\sigma_D)] + \frac{2}{4}\sigma_D = \sigma_D - \frac{\sigma_D^2}{4}$. Therefore, despite $\sigma_M > \sigma_D$ the source shares the story with both outlets if $\sigma_M \leq 2\sigma_D - \frac{\sigma_D^2}{2}$.

Second, there are parameters where one firm is less likely to research than two, i.e. $\sigma_M < \sigma_D$, and μ is very low, and yet the source prefers to share the story with two

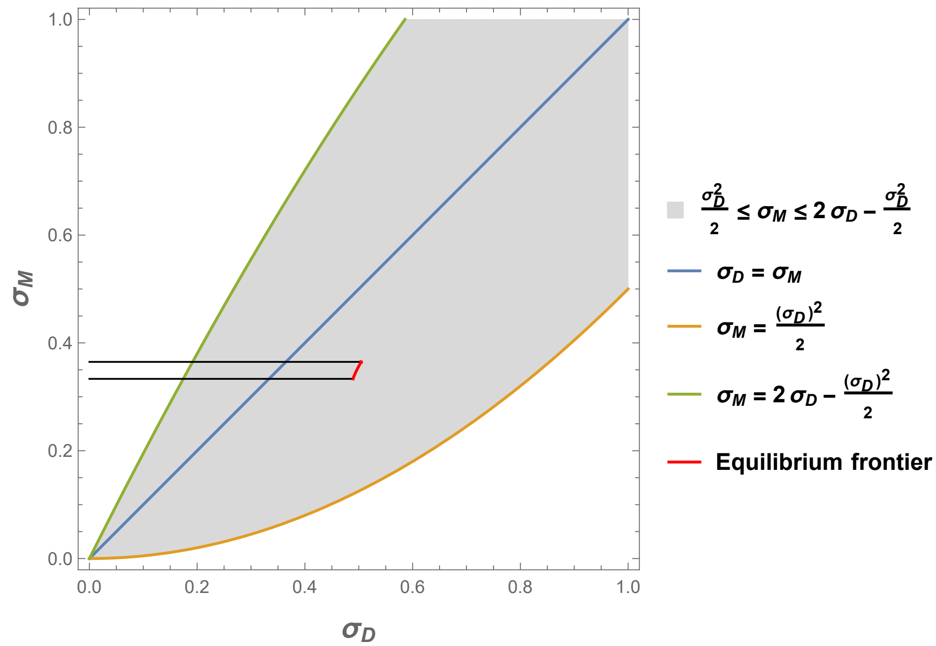

Figure 2: Equilibria in $\sigma_D - \sigma_M$ space and the behavior of the source

outlets. Doing so is rational because competition between two firms ensures the total probability of being published in $t = 1$ is larger under a duopoly. When shared with one, this probability is equal to $\frac{1}{2} + \frac{1}{2}(1 - \sigma_M) = 1 - \frac{\sigma_M}{2}$. When shared with both it is given by $\frac{1}{4} + \frac{2}{4} + \frac{1}{4}[(1-\sigma_D)^2 + 2\sigma_D(1-\sigma_D)] = 1 - \frac{\sigma_D^2}{4}$. So, now despite $\sigma_M < \sigma_D$ the source shares the story with both outlets if $\sigma_M \geq \frac{\sigma_D^2}{2}$.

We now look at possible equilibria that can arise in the $\sigma_D - \sigma_M$ space relative to the source's preferences. We begin with the following definition.

Definition 1 (Equilibrium frontier) *The equilibrium frontier is given by the combination of equilibrium σ_D and σ_M generated by varying $\pi \in [.5, 1]$ for $v = 0$ and a fixed $\bar{c}$ and ε.*

The equilibrium frontier shows the maximum equilibrium value that σ_D can take for any equilibrium σ_M. As proved in Lemma 2, when $v = 0$, $\sigma_D > \sigma_M$. Therefore, the frontier lies to the right of the 45° line. In addition, note that it is upwards-sloping. The positive slope is a result of the fact that both σ_M and σ_D are decreasing functions of

π.[17] A northeast movement along the frontier arises due to a decrease in π.

With the equilibrium frontier plotted graphically, one can see the set of all possible equilibrium values that might arise for different parameter ranges. Particularly, increasing v is a leftward movement from the frontier along the same σ_M. For v sufficiently high, $\sigma_D = 0$ while $\sigma_M > 0$ (see Corollary 3). We are now left with comparing these equilibrium values with what the source wants.

We show our third main result for the case of $\mu = 0$ so that the source only cares about getting the story out quickly independent of its accuracy level. Political actors are often interested in doing so to highlight their achievements or to bring out potentially damaging information about their competitors. Twitter and other social media platforms are one way to communicate such stories, which are then picked up by media outlets and relayed to the public without further research.

Proposition 8 *When the source does not care about accuracy, i.e., $\mu = 0$,*

- *there exists an $\varepsilon > 0$ small enough and $\bar{v}$ such that for $v < \bar{v}$, the source sends the story to one outlet and sends to two in all other cases, and*
- *there exists an $\varepsilon > 0$ large enough such that the source sends the story to both outlets.*

When the intrinsic motivation to conduct research is high then outlets in either situation are more likely to conduct research. By sending to both outlets, she is able to create preemption risk as well. On the other hand, when intrinsic motivation is low, outlets are less likely to research. Now, the source does not always want to share the story with both. Notably, when v is low the source wants to share information with just one. Sending to both risks the outlets trying to separate by doing research, thereby increasing the overall probability of research. However, again when v is high, the source

[17] The proofs have been omitted from the main text for the sake of brevity.

is happy to share the story with both as preemption concerns will become salient for the outlets.[18]

6 Conclusion

There have been increasing concerns in the past decade about how the Internet has altered the incentives of media outlets pushing them towards speed-driven journalism. Our model showed that conventional wisdom about the effect of competition and the modern digital environment on the media market should be taken *cum grano salis*. We proved that competition in itself may make it easier for better outlets with a culture of researching stories to engage in more research-driven journalism to separate themselves from those that do not. This result and intuition find support in some of the new media studies literature such as in Knobel (2018) and Carson (2019).

It is, however, worth emphasizing the importance of a "sophisticated" audience that values accuracy and can observe the sequence of publication. Regarding the first kind of sophistication, Gentzkow and Shapiro (2008) suggest that scoop value is usually not too high in the media markets. But at the same time, some media scholars have argued that the audience usually seeks information earlier on social media. The latter kind might also be an issue if technology deters the audience from seeing the sequence. Lionel Barber, the Editor of *Financial Times*, points out, "Technology has (also) flattened the digital plain, creating the illusion that all content is equal. It has made it possible for everyone to produce and distribute content that looks equally credible".

Our paper is one of the first to incorporate preemption and reputation concerns in a single model by thinking of a natural setting where both incentives play a role. It generally covers settings that have both of these features. For instance, competing researchers working to solve similar problems and hoping to convince a market about

[18] We present the proof for a general μ, but since that case does not produce sharp predictions, we have not included it in the main text.

their ability face a similar newsroom dilemma. Technology firms face a speed-accuracy tradeoff as they build products and technology to match consumer preferences. Our main results have a natural interpretation in these situations. Notably, better research in competitive environments requires that the initial research idea is not too well-developed.

Lastly, our model also produces important testable predictions about how the modern digital environment has altered the media landscape. First, we should see better reporting of non-urgent issues in the Internet age as the outlets try to build a reputation on such stories. Second, the effect of the Internet on the reporting of breaking news-type stories is ambiguous. It might improve because of better source information but might deteriorate because of more time pressure.

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Appendices

A Proofs from the main text

Proof of Observation 1

Proof. Suppose that the outlet chooses $d = pub$. Without loss of generality, suppose that $s^i = a$. It is easy to see that $\Pr(\omega = a|s^i = a) > \Pr(\omega = b|s^i = a)$ because

$$\frac{\pi\frac{1}{2}}{\pi\frac{1}{2} + (1-\pi)\frac{1}{2}} > \frac{(1-\pi)\frac{1}{2}}{\pi\frac{1}{2} + (1-\pi)\frac{1}{2}}$$

which is true because $\pi > \frac{1}{2}$. ■

Proof of Lemma 1

Proof. First part. Without loss of generality, suppose that $s^i = a$. Then, if i chooses to publish, it will endorse state a, i.e. send message $m = a$. by Bayes' rule,

$$\Pr(\omega = a|s^i = a) = \frac{\pi\frac{1}{2}}{\pi\frac{1}{2} + (1-\pi)\frac{1}{2}} = \pi$$

as claimed.

Second part. We are interested in the probability that j matches the state from choosing $d = pub$ when i has received a signal s^i. This is equal to

$$\Pr(s^j = a|s^i)\Pr(\omega = a|s^j = a \text{ and } s^i) + \Pr(s^j = b|s^i)\Pr(\omega = b|s^j = b \text{ and } s^i) \quad \text{(A.1)}$$

Note that, for a generic s^j, by Bayes' rule we have that $\Pr(s^j|s^i) = \frac{\Pr(s^j \text{ and } s^i)}{\Pr(s^i)}$ and

$$\Pr(\omega = s^j|s^j \text{ and } s^i) = \frac{\Pr(s^j \text{ and } s^i|\omega = s^j)\Pr(\omega = s^j)}{\Pr(s^j \text{ and } s^i)}$$

As a consequence, (A.1) can be simplified to

$$\frac{\Pr(s^j = a \,\text{and}\, s^i|\omega = a)\Pr(\omega = a)}{\Pr(s^i)} + \frac{\Pr(s^j = b \,\text{and}\, s^i|\omega = b)\Pr(\omega = b)}{\Pr(s^i)} \tag{A.2}$$

However, since signals are independent, conditional on the state,

$$\Pr(s^j \,\text{and}\, s^i|\omega = s^j) = \Pr(s^j|\omega = s^j)Pr(s^i|\omega = s^j)$$

Moreover, $\Pr(s^j|\omega = s^j) = \pi$. Hence, (A.2) becomes

$$\pi\frac{\Pr(s^i|\omega = a)\Pr(\omega = a) + \Pr(s^i|\omega = b)\Pr(\omega = b)}{\Pr(s^i)} = \pi$$

as claimed. ■

Proof of Proposition 2

Proof. Suppose that a high outlet chooses $d = res$ with probability σ. Reminding ourselves from the main text that

$$\gamma(R) = \frac{\sigma + (1-\sigma)\pi}{\sigma + (1-\sigma)\pi + \pi}$$

$$\gamma(W) = \frac{(1-\sigma)(1-\pi)}{(1-\sigma)(1-\pi) + (1-\pi)} = \frac{1-\sigma}{2-\sigma}$$

from Bayes' rule and using the fact that a low outlet always chooses pub.

A high outlet optimally chooses res if

$$\gamma(R) - c \geq \pi\gamma(R) + (1-\pi)\gamma(W) \implies c \leq (1-\pi)(\gamma(R) - \gamma(W)) := c_M$$

In equilibrium the conjectured σ must be equal to the actual one, hence it must be that

$$\sigma^* = F(c_M(\sigma^*)) = \frac{c_M(\sigma^*) + \varepsilon}{\bar{c} + \varepsilon}. \tag{A.3}$$

We need to check if such a fixed point exists. To do so, three observations are in order. First, note that both the LHS and RHS of the above are continuous in σ^*. Second, LHS$(\sigma^* = 0) = 0 <$ RHS$(\sigma^* = 0) = \frac{\varepsilon}{\bar{c}+\varepsilon}$ (as $c_M = 0$ at $\sigma^* = 0$). Third, LHS$(\sigma^* = 1) = 1 >$ RHS$(\sigma^* = 1) = F(\frac{1-\pi}{1+\pi})$. Therefore, the above is true.

Finally, we need to check for the uniqueness of the fixed point. Note that

$$\frac{\partial \text{RHS}}{\partial \sigma^*} = \frac{1-\pi}{\bar{c}+\varepsilon}\left[\frac{\pi(1-\pi)}{(\sigma^* + (1-\sigma^*)\pi + \pi)^2} + \frac{1}{(2-\sigma^*)^2}\right] > 0,$$

but the sign of

$$\frac{\partial^2 \text{RHS}}{\partial (\sigma^*)^2} = \frac{2(1-\pi)}{\bar{c}+\varepsilon}\left[-\frac{\pi(1-\pi)^2}{(\sigma^* + (1-\sigma^*)\pi + \pi)^3} + \frac{1}{(2-\sigma^*)^3}\right]$$

is not clear immediately. $\frac{\partial^2 \text{RHS}}{\partial (\sigma^*)^2} > 0$ requires

$$-\pi(1-\pi)^2(2-\sigma^*)^3 + (\sigma^* + (1-\sigma^*)\pi + \pi)^3 > 0 \tag{A.4}$$

It is easy to see that the LHS of (A.4) is strictly increasing in σ^* for all $\pi \in (0.5, 1]$. Moreover, the LHS of (A.4) when we substitute $\sigma^* = 0$ is $-1 + 2\pi > 0$. As a consequence, the RHS of (A.3) is strictly increasing and convex. Combined with the above, it means that there is only one fixed point in the $[0, 1]$ interval. ■

Proof of Proposition 3

Proof. If θ is known, then by choosing *pub* in $t = 1$ a high quality outlet receives a payoff of

$$\frac{1}{2}\frac{v}{2} + \frac{1}{2}\left[v\sigma + \frac{v}{2}(1-\sigma)\right] + \mathbb{1}\{\theta = h\},$$

where σ is the (symmetric) probability that the high-type competitor engages in more research. By instead choosing *res* and publishing in $t = 2$ a high type outlet gets a payoff of $\frac{1}{2}\sigma\frac{v}{2} + \mathbb{1}\{\theta = h\} - c$. Comparing the two, each outlet is willing to investigate if and only f $c \leq -\frac{v}{2}$. As a consequence, $\sigma_D^* = F\left(-\frac{v}{2}\right)$ in symmetric equilibrium. Research happens with positive probability when $-\frac{v}{2} > -\varepsilon$, which can be rearranged to $v < 2\varepsilon$. ∎

Proof of Proposition 4

Proof. We complete this proof in several steps. To begin with, we conjecture that whenever an outlet chooses to publish, it is optimal to endorse the state suggested by the signal. This will be verified at the end of the proof.

Step 1: We begin by showing that in any signal-based equilibria outlets' period 1 decision on whether to research or publish is described by a threshold on c. This follows from the discussion in the text. Let σ^i and σ^j be the conjectured strategies. Then equation (A.5) defines the threshold c_D^i for outlet i.

$$c^i \leq \frac{1}{2}\left[\left(\gamma^i(\varnothing) - \gamma^i(1)\right)\left(\sigma^j - (2-\sigma^j)\pi^2\right) + (2-\sigma^j)\left(1 - \gamma^i(1)\right)\right] - \frac{1}{2}v := c_D^i \quad \text{(A.5)}$$

where $\gamma(\varnothing) = \frac{\sigma^i\sigma^j + (1-\sigma^i)(2-\sigma^j)\pi^2}{\sigma^i\sigma^j + (2-\sigma^i)(2-\sigma^j)\pi^2}$ and $\gamma(1) = \frac{1-\sigma^i}{2-\sigma^i}$. The problem is identical for player j.

Step 2: Next, we show that for any σ^j there is only one σ^i that solves the equilibrium fixed point for player i.

Given that cost is uniformly distributed in $[-\varepsilon, \bar{c}]$ and that, in equilibrium the conjectured probability of investigation must be equal to the actual probability, the equilibrium levels of σ^i and σ^j must be the solutions of

$$\sigma^i = F(c_D^i(\sigma^i, \sigma^j)) \text{ and } \sigma^j = F(c_D^j(\sigma^j, \sigma^i))$$

where

$$F(c_D^i(\sigma^i, \sigma^j)) = \begin{cases} 0 & c_D^i(\sigma^i, \sigma^j) < -\varepsilon \\ \frac{c_D^i(\sigma^i, \sigma^j) + \varepsilon}{\bar{c} + \varepsilon} & -\varepsilon \leq c_D^i(\sigma^i, \sigma^j) \leq \bar{c} \\ 1 & c_D^i(\sigma^i, \sigma^j) > \bar{c} \end{cases}$$

and

$$f(c_D^i(\sigma^i, \sigma^j)) = \begin{cases} 0 & c_D^i(\sigma^i, \sigma^j) < -\varepsilon \\ \frac{1}{\bar{c} + \varepsilon} & -\varepsilon \leq c_D^i(\sigma^i, \sigma^j) \leq \bar{c} \\ 0 & c_D^i(\sigma^i, \sigma^j) > \bar{c} \end{cases}$$

We want to show that, for every σ^j, there is only one σ^i that solves $\sigma^i = F(c_D^i(\sigma^i, \sigma^j))$.

1. The LHS is linear, with a slope equal to 1, starting at 0 and ending at 1.
2. As $c_D^i(\sigma^i = 1, \sigma^j) < 1 < \bar{c}$, the RHS evaluated at $\sigma^i = 1 < 1 =$ LHS at $\sigma^i = 1$;
3. The RHS evaluated at $\sigma^i = 0$ is greater than or equal to zero.
4. For any σ^j, both LHS and RHS are continuous in σ^i.

Hence, they cross at least once, and there is at least one solution to this fixed point problem.

To show that they cross only once, we need to show that the slope of the RHS is never above 1. First, note that the slope of the RHS is either 0 or $f(c_D^i)\frac{\partial c_D^i}{\partial \sigma^i}$. Second, $\frac{\partial \gamma^i(\varnothing)}{\partial \sigma^i} = \frac{(\sigma^j - (2-\sigma^j)\pi^2)\pi^2(2-\sigma^j)}{(\sigma^i\sigma^j + (2-\sigma^i)(2-\sigma^j)\pi^2)^2}$, whose sign depends on the sign of $(\sigma^j - (2-\sigma^j)\pi^2)$ and $\frac{\partial \gamma^i(1)}{\partial \sigma^i} =$

$\frac{-1}{(2-\sigma^i)^2} < 0$. Using these we can write $\frac{\partial c_D^i}{\partial \sigma^i} = \frac{1}{2}\left[\frac{(\sigma^j-(2-\sigma^j)\pi^2)^2\pi^2(2-\sigma^j)}{(\sigma^i\sigma^j+(2-\sigma^i)(2-\sigma^j)\pi^2)^2} + \frac{2-\pi^2(2-\sigma^j)}{(2-\sigma^i)^2}\right]$ where both terms are always positive. Third, we can show that the sign of $\frac{\partial^2 c_D^i}{\partial(\sigma^i)^2}$ is ambiguous, but $\frac{\partial^3 c_D^i}{\partial(\sigma^i)^3} \geq 0$. As a consequence, the second derivative is always increasing in σ^i and the first derivative is convex in σ^i. So, $\frac{\partial c_D^i}{\partial \sigma^i}|_{\sigma^i=1} > \frac{\partial c_D^i}{\partial \sigma^i}|_{\sigma^i=0}$, and c_D^i reaches its steepest point around $\sigma^i = 1$. Therefore, it is enough to show that $\frac{\partial c_D^i}{\partial \sigma^i}|_{\sigma^i=1} \leq 1$. This requires

$$2(\sigma^j+(2-\sigma^j)\pi^2)^2 \geq (\sigma^j-(2-\sigma^j)\pi^2)^2\pi^2(2-\sigma^j)+(\sigma^j+(2-\sigma^j)(1-\pi^2)(\sigma^j+(2-\sigma^j)\pi^2)$$

which further simplifies to

$$(\sigma^j + (2-\sigma^j)\pi^2)^2(2-\sigma^j-2+\sigma^j) \geq -4\sigma^j(2-\sigma^j)^2\pi^4.$$

This latter condition is always verified (strictly for positive σ^j, weakly when $\sigma^j = 0$).

Now, combining the above with the fact that $c_D^i(\sigma^i = 1, \sigma^j) < 1$, implies that they cannot cross more than once.

Step 3: Third, we show that if an equilibrium exists, it is unique for $\bar{c} \geq 2$.

Define $\hat{\sigma}^i(\sigma^j)$ the optimal σ^i for a given σ^j. In equilibrium, it must be that

$$\hat{\sigma}^i(\hat{\sigma}^j(\sigma^i)) = \sigma^i \tag{A.6}$$

Rearranging, the equilibrium is the solution of $\hat{\sigma}^i(\hat{\sigma}^j(\sigma^i)) - \sigma^i = 0$. Differentiating with respect to σ^i, we obtain $\frac{\partial \hat{\sigma}^i}{\partial \hat{\sigma}^j}\frac{\partial \hat{\sigma}^j}{\partial \sigma^i} - 1 = 0$. For the equilibrium to be unique (conditional on its existence), it is now sufficient to show that the LHS is negative. This implies that only one fixed point of (A.6) can be found. This happens when $\frac{\partial \hat{\sigma}^i}{\partial \hat{\sigma}^j}$ and $\frac{\partial \hat{\sigma}^j}{\partial \sigma^i}$ are between -1 and 1. As the players are identical, it is enough to show that this holds for one of them.

To show the above, begin by noting that $\sigma^i(\sigma^j)$ is implicitly defined by the unique solution of $\sigma^i - F(c_D^i(\sigma^i, \sigma^j)) = 0$. (Going forward we drop the ˆ notation with an understanding that we are concerned with optimal responses.) As $\frac{\partial c_D^i}{\partial \sigma^i}|_{\sigma^i=1} \leq 1$, we can use implicit function theorem. Therefore,

$$\frac{\partial \sigma^i}{\partial \sigma^j} = \frac{\frac{\partial F(c_D^i)}{\partial \sigma^j}}{1 - \frac{\partial F(c_D^i)}{\partial \sigma^i}} \tag{A.7}$$

Consider first the denominator of (A.7). From Step 2, we know that it is always positive. Moreover, it will be smaller the bigger is $\frac{\partial F(c_D^i)}{\partial \sigma^i}$. On the other hand, it is the biggest when $\frac{\partial F(c_D^i)}{\partial \sigma^i}$ is zero. When $\frac{\partial F(c_D^i)}{\partial \sigma^i}$ is non-zero, it is linear and increasing in $\frac{\partial c_D^i}{\partial \sigma^i}$. As this reaches its maximum for $\sigma^i = 1$, we simply replace it and look for a maximum with respect to σ^j.

$$\begin{aligned} max_{\sigma^j} \frac{\partial c_D^i}{\partial \sigma^i}|_{\sigma^i=1} &= \frac{1}{2}\left[\frac{(\sigma^j - (2-\sigma^j)\pi^2)^2\pi^2(2-\sigma^j)}{(\sigma^j + (2-\sigma^j)\pi^2)^2} + 2 - \pi^2(2-\sigma^j)\right] \\ &= \frac{1}{2}\left[2 - \frac{4\sigma^j(2-\sigma^j)^2\pi^4}{(\sigma^j + (2-\sigma^j)\pi^2)^2}\right] \\ &= 1 \end{aligned}$$

where the second equality is a rearrangement and the third one follows from the fact that this is maximized for $\sigma^j = 0$.

As a consequence, $max_{\sigma^i,\sigma^j} \frac{\partial F(c_D^i)}{\partial \sigma^i} = \frac{1}{\bar{c}+\varepsilon}$ and the smallest the denominator can be is $\frac{1}{\bar{c}+\varepsilon}$.

Second, consider the numerator. $\frac{\partial F(c_D^i)}{\partial \sigma^j}$ is either zero or $\frac{1}{\bar{c}+\varepsilon}\frac{\partial c_D^i}{\partial \sigma^j}$. Further, note that

$$\frac{\partial c_D^i}{\partial \sigma^j} = \frac{1}{2}\left[\frac{\partial \gamma^i(\varnothing)}{\partial \sigma^j}(\sigma^j - (2-\sigma^j)\pi^2) + \gamma^i(\varnothing) + \pi^2(\gamma^i(\varnothing) - \gamma^i(1)) - 1\right]. \tag{A.8}$$

Finding the overall maximum and minimum is complicated, so we look for sufficient conditions. We start out by looking at $\frac{\partial \gamma^i(\varnothing)}{\partial \sigma^j}$. After a few algebraic manipulations, we derive

$$\frac{\partial \gamma^i(\varnothing)}{\partial \sigma^j} = \frac{2\sigma^i\pi^2}{(\sigma^i\sigma^j + (2-\sigma^i)(2-\sigma^j)\pi^2)^2}$$

Its sign is positive, but it is hard to determine the maximum. We proceed as follows. First, note that

$$\frac{\partial^2\gamma^i(\varnothing)}{\partial(\sigma^j)^2} = \frac{-4(\sigma^i - (2-\sigma^i)\pi^2)\sigma^i\pi^2}{(\sigma^i\sigma^j + (2-\sigma^i)(2-\sigma^j)\pi^2)^3}$$

whose sign is ambiguous. However,

$$\frac{\partial^3\gamma^i(\varnothing)}{\partial(\sigma^j)^3} = \frac{12(\sigma^i - (2-\sigma^i)\pi^2)^2\sigma^i\pi^2}{(\sigma^i\sigma^j + (2-\sigma^i)(2-\sigma^j)\pi^2)^4}$$

which is positive. This implies that (for any σ^i) $\frac{\partial\gamma^i(\varnothing)}{\partial\sigma^j}$ is a convex function in σ^j which is maximized either at $\sigma^j = 0$ or at $\sigma^j = 1$. By substitution,

$$\frac{\partial\gamma^i(\varnothing)}{\partial\sigma^j}|_{\sigma^j=0} = \frac{\sigma^i}{2\pi^2(2-\sigma^i)^2}$$
$$\frac{\partial\gamma^i(\varnothing)}{\partial\sigma^j}|_{\sigma^j=1} = \frac{2\sigma^i\pi^2}{(\sigma^i + (2-\sigma^i)\pi^2)^2}$$

Still, we are left to determine the maximum possible value of $\frac{\partial\gamma^i(\varnothing)}{\partial\sigma^j}$ because the comparison is not straightforward. But we can show that for every π, $max_{\sigma^i}\frac{\partial\gamma^i(\varnothing)}{\partial\sigma^j}|_{\sigma^j=0} > max_{\sigma^i}\frac{\partial\gamma^i(\varnothing)}{\partial\sigma^j}|_{\sigma^j=1}$. To prove this, first, see that

$$max_{\sigma^i}\frac{\partial\gamma^i(\varnothing)}{\partial\sigma^j}|_{\sigma^j=0} = \frac{1}{2\pi^2}$$

But to get $max_{\sigma^i}\frac{\partial\gamma^i(\varnothing)}{\partial\sigma^j}|_{\sigma^j=1}$,

$$\frac{\partial}{\partial\sigma^i}\left(\frac{\partial\gamma^i(\varnothing)}{\partial\sigma^j}|_{\sigma^j=1}\right) = \frac{\partial}{\partial\sigma^i}\left(\frac{2\sigma^i\pi^2}{(\sigma^i + (2-\sigma^i)\pi^2)^2}\right) = \frac{2\pi^2(\sigma^i + (2-\sigma^i)\pi^2) - 4(1-\pi^2)\sigma^i\pi^2}{(\sigma^i + (2-\sigma^i)\pi^2)^3} \tag{A.9}$$

Note that the relevant expression in (A.9) is always positive for $\sigma^i \leq \frac{2\pi^2}{1-\pi^2}$. For a sufficiently high π, this includes the whole range of values of σ^i. Hence, the function is maximised at $\sigma^i = 1$, and

$$max_{\sigma^i} \frac{\partial \gamma^i(\varnothing)}{\partial \sigma^j}|_{\sigma^j=1} = \frac{2\pi^2}{(1+\pi^2)^2}.$$

But now it is easy to see that $\frac{1}{2\pi^2} \geq \frac{2\pi^2}{(1+\pi^2)^2}$ requires $1 + 2\pi^2 - 3\pi^4 \geq 0$, which is always true for $\pi \in (0.5, 1]$. Therefore, our claim of $max_{\sigma^i} \frac{\partial \gamma^i(\varnothing)}{\partial \sigma^j}|_{\sigma^j=0} > max_{\sigma^i} \frac{\partial \gamma^i(\varnothing)}{\partial \sigma^j}|_{\sigma^j=1}$ is true.

However, for low π, we have that $argmax_{\sigma^i} \frac{\partial \gamma^i(\varnothing)}{\partial \sigma^j}|_{\sigma^j=1} = \frac{2\pi^2}{1-\pi^2} \in [0, 1]$. In particular, this happens for $\pi^2 \leq \frac{1}{3}$. Even in this case, it is easy to show that $\frac{1}{2\pi^2} \geq \frac{2\pi^2\left(\frac{2\pi^2}{1-\pi^2}\right)}{\left((1-\pi^2)\left(\frac{2\pi^2}{1-\pi^2}\right)+2\pi^2\right)^2}$ requires $\pi^2 \leq \frac{2}{3}$, i.e. it is always the case in the range of parameters of interest. As a consequence, we have that $max_{\sigma^i} \frac{\partial \gamma^i(\varnothing)}{\partial \sigma^j}|_{\sigma^j=0} > max_{\sigma^i} \frac{\partial \gamma^i(\varnothing)}{\partial \sigma^j}|_{\sigma^j=1}$. Since we want $\frac{\partial \gamma^i(\varnothing)}{\partial \sigma^j}$ as big as possible, we can set it as $\frac{1}{2\pi^2}$ for our sufficiency conditions.

Given this, the lowest value of the numerator of $\frac{\partial \sigma^i}{\partial \sigma^j}$ from (A.7) can be found by making the relevant replacement from above to (A.8). Therefore,

$$min_{\sigma^i,\sigma^j} \frac{\partial F(c_D^i)}{\partial \sigma^i} \geq \frac{1}{\bar{c}+\varepsilon} \frac{1}{2} \left[\frac{1}{2\pi^2}(-2\pi^2) - 1 \right] = \frac{-1}{\bar{c}+\varepsilon}.$$

To see this, note that $min_{\sigma^i,\sigma^j}(\sigma^j - (2-\sigma^j)\pi^2) = -2\pi^2$, $min_{\sigma^i,\sigma^j}\gamma^i(\varnothing) \geq 0$, $min_{\sigma^i,\sigma^j}(\gamma^i(\varnothing) - \gamma^i(1)) \geq 0$. Therefore, our first sufficient condition for the uniqueness of the equilibrium is

$$\frac{-\frac{1}{\bar{c}+\varepsilon}}{1 - \frac{1}{\bar{c}+\varepsilon}} > -1,$$

which simplifies to $\bar{c} \geq 2$, as assumed.

Looking now at the upper bound, again by replacing in (A.8), note that

$$max_{\sigma^i,\sigma^j} \frac{\partial F(c_D^i)}{\partial \sigma^i} \leq \frac{1}{\bar{c}+\varepsilon} \frac{1}{2} \left[\frac{1}{2\pi^2}(1-\pi^2) + 1 + \pi^2 - 1 \right] = \frac{1}{2(\bar{c}+\varepsilon)} \left[\frac{1-\pi^2}{2\pi^2} + \pi^2 \right].$$

To see this, note that $max_{\sigma^i,\sigma^j}(\sigma^j - (2-\sigma^j)\pi^2) = 1 - \pi^2$, $max_{\sigma^i,\sigma^j}\gamma^i(\varnothing) \leq 1$, $max_{\sigma^i,\sigma^j}(\gamma^i(\varnothing) - \gamma^i(1)) \leq 1$. Therefore, our second sufficient condition for the uniqueness of the equilibrium is

$$\frac{\frac{1}{2(\bar{c}+\varepsilon)}\left[\frac{1-\pi^2}{2\pi^2}+\pi^2\right]}{1-\frac{1}{\bar{c}+\varepsilon}} < 1$$

The numerator is maximised at $\pi = \frac{1}{2}$, hence the condition simplifies to $\bar{c} + \varepsilon > \frac{15}{16}$. Again, this is satisfied for $\bar{c} \geq 2$.

Step 4: Fourth, we show that a symmetric equilibrium where $\sigma^{i*} = \sigma^{j*} = \sigma^*$ always exists. Therefore, it is also unique among the set of signal-based equilibria.

Because of symmetry, the equilibrium must be the fixed point of

$$\sigma^i = \sigma^j = \sigma^* = F(c_D(\sigma^*)) \tag{A.10}$$

where from (A.5)

$$c_D(\sigma^*) = \frac{1}{2}\left[\left(\frac{(\sigma^*)^2 + (1-\sigma^*)(2-\sigma^*)\pi^2}{(\sigma^*)^2 + (2-\sigma^*)^2\pi^2} - \frac{1-\sigma^*}{2-\sigma^*}\right)(\sigma^* - (2-\sigma^*)\pi^2) + 1\right] - \frac{1}{2}v$$

Looking at (A.10), note that both LHS and RHS are continuous on the $[0,1]$ interval. Moreover, RHS$(\sigma^* = 0) \geq 0 =$ LHS(σ^*) and $RHS(\sigma^* = 1) < 1 = LHS(\sigma^* = 1)$. Consequently, a solution exists in the $[0,1]$ interval. From the previous steps, we know that this solution is unique.

Step 5: Finally, in the symmetric equilibrium, it is optimal to endorse the state suggested by the most informative signal.

Assume that player j behaves as in the equilibrium described above. Now, by endorsing the wrong state in period 2, player i shifts beliefs from $\gamma^i(2) = 1$ to $\gamma^i(1)$ if it is the only one publishing in that period, and from $\gamma^i(\varnothing)$ to $\gamma^i(1)$ if both outlets publish in period 2. In both cases, sticking to the correct state is weakly dominant.

If outlet i chooses to publish in period 1, it is indifferent by endorsing the least likely state if it is the only one to publish in that period. If instead outlet j publishes in period 1 as well, the expected reputation of outlet i by endorsing the state suggested by the signal is $\pi^2\gamma^i(\varnothing) + (1-\pi^2)\gamma^i(1)$. By endorsing the opposite state, the expected reputation is $\pi\gamma^i(1)+(1-\pi)\left[\pi\gamma^i(\varnothing) + (1-\pi)\gamma^i(1)\right]$. Again, the former is strictly bigger than the latter because $\gamma^i(\varnothing) \geq \gamma^i(1)$. ■

Proof of Lemma 2

Proof. To show this, we compare the cost threshold in monopoly and duopoly shutting down the preemption concerns, i.e., assuming $v = 0$. We want to show that, in this case, $c_D > c_M$. This would require

$$\frac{1}{2}\left[\left(\gamma(\varnothing) - \gamma(1)\right)\left(\sigma - (2-\sigma)\pi^2\right) + 1\right] > (1-\pi)(\gamma(R) - \gamma(W)) \tag{A.11}$$

Observe that $\gamma(1) = \gamma(W) = \frac{1-\sigma}{2-\sigma}$. Moreover, define $\gamma(\varnothing) - \gamma(1) := A$. We can now rearrange equation (A.11) so that it becomes

$$\frac{1}{2}\left[A\sigma + 1\right] > (1-\pi)(\gamma_R - X) + \frac{1}{2}A(2-\sigma)\pi^2 \tag{A.12}$$

Now, after the relevant substitutions A can be simplified as $A = \frac{\sigma^2}{(2-\sigma)(\sigma^2+(2-\sigma)^2\pi^2)}$. As a consequence,

$$\frac{\partial A}{\partial \sigma} = \frac{2\sigma(2-\sigma)(\sigma^2+(2-\sigma)^2\pi^2) - \sigma^2(\sigma^2+3(2-\sigma)^2\pi^2 - 2\sigma(2-\sigma))}{((2-\sigma)(\sigma^2+(2-\sigma)^2\pi^2))^2} \tag{A.13}$$

Signing (A.13) is not easy in its current form. However, it is clear that $lim_{\sigma\to 0}\frac{\partial A}{\partial \sigma} = 0$. Moreover, we can rearrange A in a more tractable way. In particular, $A = \frac{1}{(2-\sigma)(1+\pi^2 B^2)}$ where $B = \frac{2-\sigma}{\sigma}$. Since $B > 0$ and $\frac{\partial B}{\partial \sigma} = -\frac{2}{\sigma^2} < 0$, it is now easy to see that

$$\frac{\partial A}{\partial \sigma} = \frac{1 + \pi^2 B - 2\pi^2 B\frac{\partial B}{\partial \sigma}(2-\sigma)}{((2-\sigma)(1+\pi^2B^2))^2} > 0.$$

The sign of $\frac{\partial^2 A}{\partial \sigma^2}$ is even more complicated, but as A is defined over just two parameters,

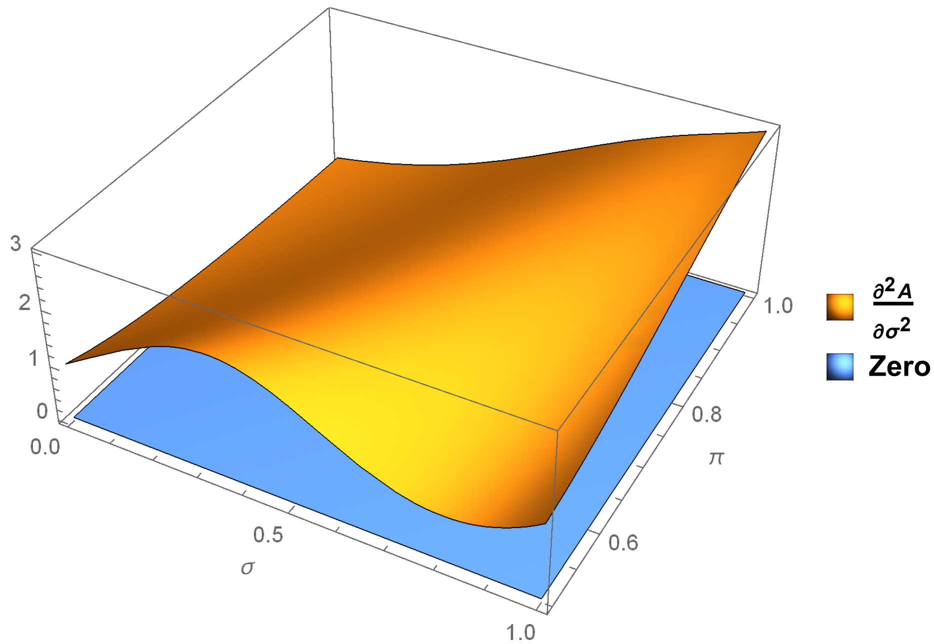

Figure 3: Proof of Lemma 2: Proving $\frac{\partial^2 A}{\partial \sigma^2} > 0$. Orange plane: $\frac{\partial^2 A}{\partial \sigma^2}$, blue plane: $0.\sigma + 0.\pi$ in $\pi - \sigma$ space.

$\sigma \in [0, 1]$ and $\pi \in (0.5, 1]$, we can prove graphically that $\frac{\partial^2 A}{\partial \sigma^2} > 0$. In particular, Figure 3 shows that $\frac{\partial^2 A}{\partial \sigma^2}$ (the orange plane) is always strictly above the zero (blue plane) for the entire set of relevant parameters.

It is now straightforward to see that in equation (A.12) $\frac{\partial \text{LHS}}{\partial \sigma} > 0$ and $\frac{\partial^2 \text{LHS}}{\partial \sigma^2} > 0$ so the LHS is strictly increasing and convex. Moreover, $\frac{\partial RHS}{\partial \sigma} > 0$.

To complete the proof, we show that LHS($\sigma = 0$) >RHS($\sigma = 1$) for all $\pi \in (0.5, 1)$. This requires

$$\frac{1}{2} > \frac{1-\pi}{1+\pi} + \frac{1}{2}\frac{\pi^2}{1+\pi^2}$$

which further simplifies to

$$1 - 3\pi + 2\pi^2 - 2\pi^3 < 0$$

Noticing that the LHS of the above is strictly decreasing in π, and it remains negative for both $\pi = \frac{1}{2}$ and $\pi = 1$, completes the proof. ■

Proof of Proposition 5

Proof. This follows directly from the strict inequality of equation (A.11) and the fact that v only reduces its LHS without affecting the RHS. ■

Proof of Corollary 1

Proof. The behavior of the monopolist is unchanged from Section 3.1. Looking at the duopoly case, by Bayes' rule

$$\gamma^i(R,.) = \frac{(1-\sigma^i)\pi + \sigma^i}{(1-\sigma^i)\pi + \sigma^i + \pi} = \gamma^i(R)$$

$$\gamma^i(W,.) = \frac{1-\sigma^i}{2-\sigma^i} = \gamma^i(W)$$

Therefore, the cost threshold for research is given by

$$\begin{aligned}
&\frac{1}{2}\left[\sigma^j\left(\frac{v}{2}+\gamma^i(R)\right) + (1-\sigma^j)\gamma^i(R)\right] + \frac{1}{2}\gamma^i(R) - c \geq \\
&\frac{1}{2}\left[\sigma^j\left(v + \pi\gamma^i(R) + (1-\pi)\gamma^i(W)\right) + (1-\sigma^j)\left(\frac{v}{2} + \pi\gamma^i(R) + (1-\pi)\gamma^i(W)\right)\right] + \\
&+\frac{1}{2}\left(\frac{v}{2} + \pi\gamma^i(R) + (1-\pi)\gamma^i(W)\right),
\end{aligned}$$

which simplifies to

$$c \leq (1-\pi)(\gamma^i(R) - \gamma^i(W)) - \frac{1}{2}v := c'_D \tag{A.14}$$

Note that the first part of (A.14) is the same as c_M, and the only term that changes is $-\frac{1}{2}v$, making it smaller than c_M.

In terms of the existence and uniqueness of the equilibrium in this setup, note that σ^{i*} and σ^{j*} are the solution of the same fixed point problem, i.e.

$$\sigma^* = F(c'_D(\sigma^*))$$

where $c'_D = c_M - \frac{1}{2}v$. The same logic of the proof of Proposition 2 applies here as well. Hence the equilibrium exists, and it is unique and symmetric. ■

Proof of Corollary 2

Proof. Consider first the case of monopoly. Here, only the high outlet can publish in period 2, which is observable. As a consequence,

$$\gamma(2) = 1$$

$$\gamma(1) = \frac{1-\sigma}{2-\sigma}$$

The monopolist chooses to investigate when $c \leq 1 - \gamma(1) := c''_M$.

In a duopoly, the beliefs are updated the same way. Each outlet is considered independently, and only the timing matters. The threshold is, therefore, given by

$$\frac{1}{2}\left[\sigma^j\left(\frac{v}{2}+1\right)+(1-\sigma^j)\right]+\frac{1}{2}-c \geq$$
$$\frac{1}{2}\left[\sigma^j\left(v+\gamma^i(1)\right)+(1-\sigma^j)\left(\frac{v}{2}+\gamma^i(1)\right)\right]+\frac{1}{2}\left(\frac{v}{2}+\gamma^i(1)\right).$$

It follows then that $c''_D = 1 - \gamma^i(1) - \frac{1}{2}v = c''_M - \frac{1}{2}v < c''_M$ as claimed.

In terms of existence and uniqueness, note that σ^* is the solution of

$$\sigma^* = F(c''(\sigma^*))$$

The RHS is continuous on the $[0, 1]$ interval, and irrespective of the market structure, it is either strictly increasing and convex or flat. Moreover, RHS$(\sigma^* = 0) \geq$LHS$(\sigma^* = 0)$ and RHS$(\sigma^* = 1) < 1 =$LHS$(\sigma^* = 1)$ since $\bar{c} > 1$. ■

Proof of Proposition 6

Proof. We drop the bars for convenience. First, note that $\bar{c}_D$ is decreasing in u. This is so because it can be rearranged as

$$\bar{c}_D = \frac{1}{2}\left[(\gamma(\varnothing) - \gamma(1))\left(\sigma^* - (2-\sigma^*)\pi^2\right) - \sigma^*\right] + \frac{3}{2} - u\left(\frac{3}{2} - \frac{\sigma^*}{2}\right)$$

where $\frac{3}{2} - \frac{\sigma^*}{2} > 0$ for any $\sigma^* \in [0,1]$. Also, c_M and σ_M^* do not change with u.

Second, consider the case when $u = 1$. We will show that $\bar{c}_D < c_M$. This requires

$$\frac{1}{2}\left[(\gamma(\varnothing) - \gamma(1))(\sigma - (2-\sigma)\pi^2)\right] < (1-\pi)(\gamma(R) - \gamma(W)).$$

Using the terminology introduced in Lemma 2, we can rewrite the above as

$$\frac{1}{2}A\sigma < (1-\pi)(\gamma(R) - \gamma(W)) + \frac{1}{2}A(2-\sigma)\pi^2.$$

The LHS and the RHS of the above equation are only functions of two variables, π and σ, defined on compact and continuous sets. Therefore, we can plot them in a graph (see Figure 4) and check that the above is true.

Third, consider the case of $u = 0$. We want to show that $\bar{c}_D > c_M$. This is equivalent to showing that

$$\frac{1}{2}\left[(\gamma(\varnothing) - \gamma(1))(\sigma - (2-\sigma)\pi^2) - \sigma\right] + \frac{3}{2} > (1-\pi)(\gamma(R) - \gamma(W)).$$

We showed in Lemma 2 that $c_D(v=0) > c_M$. It is easy to check that $\bar{c}_D(u=0) = c_D(v = 0) + 1 - \frac{1}{2}\sigma$ where $1 - \frac{1}{2}\sigma > 0$ for all $\sigma \in [0,1]$. Therefore, $\bar{c}_D(u=0) > c_D(v=0) > c_M$.

Combining the three parts above, our result follows. ■

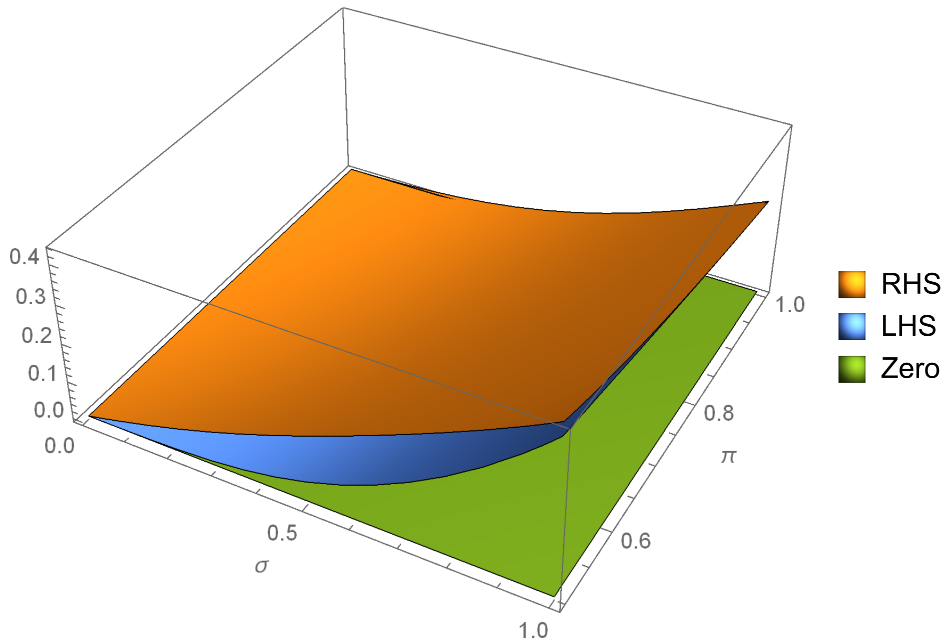

Figure 4: Proof of Proposition 6: Proving LHS < RHS. Orange plane: RHS, blue plane: LHS, and green plane: $0.\sigma + 0.\pi$ in the $\pi - \sigma$ space.

Proof of Proposition 7

Proof. We drop the bars and stars for convenience. Reminding ourselves that

$$V = \frac{(4-\sigma^2)}{4}\pi u + \frac{2}{4}\sigma(2-\sigma)(1-u) + \frac{1}{4}\sigma^2 u,$$

we first take the first derivative of V with respect to π (we drop the stars and D in what follows for convenience).

$$\begin{aligned} \frac{\partial V}{\partial \pi} &= u\frac{(4-\sigma^2)}{4} + \left[\frac{\pi u}{2}(\sigma-4) + \frac{(1-u)}{2}2(1-\sigma) + \frac{(u)}{2}\sigma\right]\frac{\partial \sigma}{\partial \pi} \\ &= u\frac{(4-\sigma^2)}{4} + \frac{2(1-\sigma) - u[(2+4\pi) - \sigma(\pi+3)]}{2}\frac{\partial \sigma}{\partial \pi} \end{aligned} \tag{A.15}$$

Now, we need to show under what conditions $\frac{\partial \sigma}{\partial \pi} < 0$. Reminding that σ is implicitly defined by (B.3) define

$$K := \sigma - \left[\frac{1}{2}\left[\left(\gamma(\varnothing) - \gamma(1)\right)\left(\sigma - (2-\sigma)\pi^2\right) - \sigma(1-u)\right] + \frac{3}{2}(1-u)\right]\frac{1}{\bar{c}+\varepsilon} - \frac{\varepsilon}{\bar{c}+\varepsilon}$$

Further, using the definitions in the proof of Lemma 2, we can rewrite K as

$$K = \sigma - \frac{1}{2(\bar{c}+\varepsilon)}\left[A(\sigma - (2-\sigma)\pi^2) - \sigma(1-u)\right] - \frac{3}{2(\bar{c}+\varepsilon)}(1-u) - \frac{\varepsilon}{\bar{c}+\varepsilon}$$

Differentiating and simplifying, we first obtain

$$\begin{aligned} \frac{\partial K}{\partial \pi} := K_\pi &= -\frac{1}{2(\bar{c}+\varepsilon)}\left[\frac{-2\pi B^2(\sigma - (2-\sigma)\pi^2)}{(2-\sigma)(1+\pi^2B^2)^2} - \frac{2\pi}{1+\pi^2B^2}\right] \\ &= \frac{1}{2(\bar{c}+\varepsilon)}\frac{1+B}{(1+\pi^2B^2)^2} > 0, \end{aligned} \tag{A.16}$$

and second, we obtain

$$\begin{aligned} \frac{\partial K}{\partial \sigma} := K_\sigma &= 1 - \frac{1}{2(\bar{c}+\varepsilon)}\left[\frac{\partial A}{\partial \sigma}(\sigma - (2-\sigma)\pi^2) + (1+\pi^2)A - (1-u)\right] \\ &= 1 + \frac{1}{2(\bar{c}+\varepsilon)}(1-u) - \frac{1}{2(\bar{c}+\varepsilon)}\left[\frac{\partial A}{\partial \sigma}(\sigma - (2-\sigma)\pi^2) + (1+\pi^2)A\right] \\ &= 1 + \frac{1}{2(\bar{c}+\varepsilon)}(1-u) - \frac{1}{\bar{c}+\varepsilon}\frac{\partial c_D}{\partial \sigma} \end{aligned} \tag{A.17}$$

where c_D is the cost threshold we derived in Proposition 4.

We can now show that $\frac{\partial c_D}{\partial \sigma} \leq 1$ in the neighborhood of the equilibrium σ. The proof for this is presented in Proposition D2 (Appendix D) for a generic prior q. Therefore, it is also true in our special case of $q = \frac{1}{2}$.

Putting these two facts together and using the Implicit Function Theorem, we can now conclude that $\frac{\partial \sigma}{\partial \pi} = -\frac{K_\pi}{K_\sigma} < 0$.

Finally, we want to find the condition under which $\frac{\partial V}{\partial \pi} < 0$. From (A.15), this happens when

$$u\frac{(4-\sigma^2)}{4} < \frac{2(1-\sigma)-u[(2+4\pi)-\sigma(\pi+3)]}{2}\sigma_\pi,$$

where $\left(-\frac{\partial\sigma}{\partial\pi}\right) := \sigma_\pi > 0$. We wish to determine the behavior of the LHS and the RHS above with u. Begin with the LHS and note that it is linearly increasing in u, with it being 0 at $u = 0$ and $1 - \frac{\sigma^2}{4} > 0$ at $u = 1$. For the RHS, begin by noting that $\sigma_\pi > 0$ for any u. Now, at $u = 0$, RHS $= (1-\sigma)\sigma_\pi|_{u=0} > 0$. But at $u = 1$, RHS $= \frac{\pi(-4+\sigma)+\sigma}{2}\sigma_\pi|_{u=1} < 0$ because $\frac{\pi(-4+\sigma)+\sigma}{2} < 0$. Since the RHS is a continuous function of u, it must cross the LHS at least once. Therefore, $\bar{u}^V$ exists and lies between 0 and 1. ■

Proof of Lemma 3

Proof. Comparing the source's expected utility given by expressions in (1) and (2) and simplifying gives the following condition to prefer two firms:

$$\mu(1-\pi)(2\sigma_M - \sigma_D(4-\sigma_D)) \leq 2\sigma_M - \sigma_D^2 \tag{A.18}$$

We discuss different cases based on possible values of σ_M and σ_D.

Case 1: v is very high so that $\sigma_D = 0$. Substituting in A.18 gives that the source prefers to send the story to both outlets if

$$\mu \leq \frac{1}{1-\pi} > 1$$

Therefore, if v is very large, it is possible that $\mu > 1$ (so that the source cares relatively more about matching the state) and $\sigma_D = 0$ (so that in duopoly, no one does research), but still the source prefers to share information with both the outlets. This happens because $\pi > .5$, and the source still cares about getting the information out quickly.

Case 2: v is high enough so that $\sigma_D < \sigma_M$. Now, the RHS of equation (A.18) is greater than zero. But first, σ_D might not be too small so that in the LHS < 0 i.e. $2\sigma_M \leq \sigma_D(4 - \sigma_D)$. In this case, sending to both is always preferred independent of μ. Therefore, sending it to both is preferred if

$$\sigma_D < \sigma_M \leq \frac{\sigma_D(4 - \sigma_D)}{2}.$$

Second, σ_D might, in fact be very small so that on the LHS > 0 i.e. $2\sigma_M > \sigma_D(4-\sigma_D)$. In this case, sending to both is preferred only if

$$\mu \leq \frac{2\sigma_M - \sigma_D^2}{2\sigma_M - \sigma_D(4 - \sigma_D)} \frac{1}{(1 - \pi)}.$$

Case 3: v is small so that $\sigma_D > \sigma_M$. Again there are two possible situations. First, consider the case in which σ_D is not too large so that the RHS of equation (A.18) is still positive, i.e., $2\sigma_M \geq \sigma_D^2 \implies \sigma_M \geq \frac{\sigma_D^2}{2}$. Now, in this case, we want to see whether the LHS can be negative i.e. if $\sigma_M < \frac{\sigma_D(4-\sigma_D)}{2}$. But this must be true because $\sigma_D > \sigma_M$ and we know that $\frac{\sigma_D(4-\sigma_D)}{2} > \sigma_D$. Therefore, the LHS is negative and the RHS is positive, so the condition outlined in (A.18) is satisfied. Sending to both is always preferred if

$$\frac{\sigma_D^2}{2} \leq \sigma_M < \sigma_D.$$

Second, σ_D might, in fact be very large so that the RHS is negative, i.e. $\sigma_M < \frac{\sigma_D^2}{2}$. Now, it cannot be that the LHS is positive because that requires $\sigma_M > \frac{\sigma_D(4-\sigma_D)}{2}$ which contradicts $\sigma_M < \sigma_D$. Therefore, LHS must also be negative. From condition (A.18), the source prefers both outlets only if

$$\mu \geq \frac{\sigma_D^2 - 2\sigma_M}{\sigma_D(4 - \sigma_D) - 2\sigma_M} \frac{1}{(1 - \pi)}.$$

Case 4: v is such that $\sigma_D = \sigma_M := \sigma$. When this is the case, the condition (A.18) reduces to

$$-\mu(1-\pi)(2-\sigma) < (2-\sigma)$$

which is always true. Therefore, sending it to both is preferred.

Our result follows from combining all the above cases. ■

Proof of Proposition 8

Proof. The proof is by construction. We have already constructed the equilibrium frontier and the set of all possible equilibria for a given $\bar{c}$ and ε.

We now show what happens as $\varepsilon \to 0$. Consider σ_M first. From Proposition 2, observe that as $\varepsilon \to 0$ LHS$(\sigma = 0) = 0 \approx$ RHS$(\sigma = 0) = \frac{\varepsilon}{\bar{c}+\varepsilon} \to 0$ in equation (A.3). Therefore, for any π the only fixed point equilibrium $\to 0$.

Now, consider σ_D at $v = 0$. Fix a π. We know that as $\varepsilon \to 0$, since $c_D(\sigma = 0) = \frac{1}{2}$, we have that RHS$(\sigma = 0) \to \frac{1}{2\bar{c}}$ in equation (A.10). But this is strictly greater than LHS$(\sigma = 0) = 0$. Therefore, the equilibrium fixed point $\sigma_D > 0$ and also $\frac{\sigma_D^2}{2} > 0$. Moreover, this is true for any π.

Therefore, in the $\sigma_D - \sigma_M$ space as $\varepsilon \to 0$, the equilibrium frontier lies below the $\sigma_M = \frac{\sigma_D^2}{2}$ line.

Now, let us look at what happens as $\varepsilon \to \infty$. Given that the fixed point is defined by $\sigma^* = \frac{c^*+\varepsilon}{\bar{c}+\varepsilon}$, both σ_M and σ_D approach 1 (without ever being exactly equal to 1). However, because the frontier is defined for $v = 0$ case, the frontier lies close to and to the right of the $\sigma_M = \sigma_D$ line.

Combining the two observations above with Lemma 3, we get our proposition. ■

Appendices B, C, D, E and F are **for online publication**.

B Duopoly case with microfounded audience preferences presented in Section 4

Proposition B1 *Let there be a fraction u of audience available to the first outlet publishing and let $\bar{c} \geq 2.5$. If there are two media outlets and their types are not known to the audience, there exists a unique and symmetric equilibrium probability with which a high outlet does research, $\bar{\sigma}^{i*} = \bar{\sigma}^{j*} := \bar{\sigma}^* = F(\bar{c}_D)$ such that*

$$\bar{c}_D = \frac{1}{2}\left[\left(\gamma(\varnothing) - \gamma(1)\right)\left(\bar{\sigma}^* - (2-\bar{\sigma}^*)\pi^2\right) - \bar{\sigma}^*(1-u)\right] + \frac{3}{2}(1-u)$$

where $\gamma(\varnothing) = \frac{(\bar{\sigma}^*)^2 + (1-\bar{\sigma}^*)(2-\bar{\sigma}^*)\pi^2}{(\bar{\sigma}^*)^2 + (2-\bar{\sigma}^*)^2\pi^2}$ *and* $\gamma(1) = \frac{1-\bar{\sigma}^*}{2-\bar{\sigma}^*}$.

Proof. We proceed in steps as outlined in Proposition 4. We drop the bars from σ for convenience.

Step 1: We begin by showing that in any signal-based equilibria outlets' period 1 decision on whether to research or publish is described by a threshold on c. This follows from the discussion in the text. Let σ^i and σ^j be the conjectured strategies. Then equation (B.1) defines the threshold c^i_D for outlet i.

$$c^i \leq \frac{1}{2}\left[\left(\gamma^i(\varnothing) - \gamma^i(1)\right)\left(\sigma^j - (2-\sigma^j)\pi^2\right) + (2-\sigma^j)\left(1-\gamma^i(1)\right) - \sigma^j(1-u)\right] + 1 - \frac{3}{2}u := \bar{c}^i_D \tag{B.1}$$

where $\gamma(\varnothing) = \frac{\sigma^i\sigma^j + (1-\sigma^i)(2-\sigma^j)\pi^2}{\sigma^i\sigma^j + (2-\sigma^i)(2-\sigma^j)\pi^2}$ and $\gamma(1) = \frac{1-\sigma^i}{2-\sigma^i}$. The problem is identical for player j.

Step 2: Next, we show that for any σ^j there is only one σ^i that solves the equilibrium fixed point for player i.

All of the definitions from Proposition 4 remain unaltered.

We want to show that, for every σ^j, there is only one σ^i that solves $\sigma^i = F(\bar{c}^i_D(\sigma^i, \sigma^j))$.

1. The LHS is linear, with slope equal to 1, starting at 0 and ending at 1.

2. Now, $\bar{c}^i_D(\sigma^i = 1, \sigma^j) = c^i_D(\sigma^i = 1, \sigma^j, v = 0) + (1-u)(1-\frac{\sigma^j}{2})$, where each term is less than or equal to 1. But since $\bar{c} \geq 2.5$, therefore $\bar{c}^i_D(\sigma^i = 1, \sigma^j) < \bar{c}$. As a result, the RHS evaluated at $\sigma^i = 1 < 1 =$ LHS at $\sigma^i = 1$;

3. The RHS evaluated at $\sigma^i = 0$ is greater than or equal to zero.

4. For any σ^j, both LHS and RHS are continuous in σ^i.

Hence, they cross at least once and there is at least one solution to this fixed point problem.

Further, note that $\bar{c}^i_D$ behaves the same way as c^i_D with respect to σ^i. Therefore, the rest of the proof in this step is as before.

Step 3: Third, we show that if an equilibrium exists, it is unique for $\bar{c} \geq 2.5$.

Other than changing the relevant definitions to include σ, nothing changes in this step until we evaluate $\frac{\partial \bar{c}^i_D}{\partial \sigma^j}$

$$\frac{\partial \bar{c}^i_D}{\partial \sigma^j} = \frac{1}{2}\left[\frac{\partial \gamma^i(\varnothing)}{\partial \sigma^j}(\sigma^j - (2-\sigma^j)\pi^2) + \gamma^i(\varnothing) + \pi^2(\gamma^i(\varnothing) - \gamma^i(1)) - (2-u)\right]. \quad \text{(B.2)}$$

Again, the rest of the proof remains unaltered until we find the first sufficient condition. The lowest value of the numerator of $\frac{\partial \sigma^i}{\partial \sigma^j}$ from (A.7) can be found by making the relevant replacement from above to (B.2). Therefore,

$$min_{\sigma^i,\sigma^j}\frac{\partial F(\bar{c}^i_D)}{\partial \sigma^j} \geq \frac{1}{\bar{c}+\varepsilon}\frac{1}{2}\left[\frac{1}{2\pi^2}(-2\pi^2) - (2-u)\right] = \frac{-1}{\bar{c}+\varepsilon}\left(\frac{3-u}{2}\right).$$

Therefore, our new first sufficient condition for the uniqueness of the equilibrium is

$$\frac{-\frac{1}{\bar{c}+\varepsilon}\left(\frac{3-u}{2}\right)}{1-\frac{1}{\bar{c}+\varepsilon}} > -1,$$

which simplifies to $\bar{c} \geq \frac{5-u}{2}$. The highest value possible of $\frac{5-u}{2}$ is 2.5 at $u = 0$, which is assumed.

Looking now at the upper bound, again by replacing in (B.2) we get

$$max_{\sigma^i,\sigma^j} \frac{\partial F(\bar{c}_D^i)}{\partial \sigma^i} \leq \frac{1}{\bar{c}+\varepsilon} \frac{1}{2} \left[\frac{1}{2\pi^2}(1-\pi^2) + 1 + \pi^2 - 2 + u\right] = \frac{1}{2(\bar{c}+\varepsilon)} \left[\frac{1}{2\pi^2} + \pi^2 - \frac{3}{2} + u\right].$$

Therefore, our second new sufficient condition for the uniqueness of the equilibrium is

$$\frac{\frac{1}{2(\bar{c}+\varepsilon)}\left[\frac{1}{2\pi^2} + \pi^2 - \frac{3}{2} + u\right]}{1-\frac{1}{\bar{c}+\varepsilon}} < 1$$

The numerator is maximised at $\pi = \frac{1}{\sqrt{2}}$, hence the condition simplifies to $\bar{c} + \varepsilon > \frac{u+2}{2}$. Again, this is satisfied for $\bar{c} \geq 2.5$ since $\frac{5-u}{2} > \frac{u+2}{2}$ for $u \in [0, 1]$.

Step 4: Fourth, we show that a symmetric equilibrium where $\sigma^{i*} = \sigma^{j*} = \sigma^*$ always exists. Therefore, it is also unique among the set of signal-based equilibria.

Because of symmetry, the equilibrium must be the fixed point of

$$\sigma^i = \sigma^j = \sigma^* = F(c_D(\sigma^*)) \tag{B.3}$$

where from (B.1)

$$c_D(\sigma^*) = \frac{1}{2}\left[\left(\frac{(\sigma^*)^2 + (1-\sigma^*)(2-\sigma^*)\pi^2}{(\sigma^*)^2 + (2-\sigma^*)^2\pi^2} - \frac{1-\sigma^*}{2-\sigma^*}\right)(\sigma^* - (2-\sigma^*)\pi^2) - \sigma^*(1-u)\right] - \frac{3}{2}(1-u) \tag{B.4}$$

Looking at (B.3), note that both LHS and RHS are continuous on the $[0, 1]$ interval. Moreover, RHS($\sigma^* = 0$) $\geq 0 =$ LHS(σ^*) and RHS($\sigma^* = 1$) $< 1 =$LHS($\sigma^* = 1$).

Consequently, a solution exists in the $[0, 1]$ interval. From the previous steps, we know that this solution is unique.

Step 5: Finally, we show that in the symmetric equilibrium, it is optimal to endorse the state suggested by the most informative signal.

This is true because now there is more incentive to build a reputation. Since reputation requires matching the state, there is even less reason not to endorse the state suggested by the most informative equilibrium. ■

C Allowing for sitting on information

In this appendix, we show that allowing outlets to "sit on information" (i.e. just refrain from publishing until period 2 without acquiring the additional signal) does not preclude the equilibrium outlined in Proposition 4. We prove it formally for sufficiently low π and then use mathematical simulation to argue that it holds more generally. The uniqueness of such an equilibrium (among signal-based equilibria), however, is not obvious anymore. We make only one change to the model described in Section 2. Now $d^i \in \{res, pub, wait\}$, where $d^i = wait$ means that the outlet does not acquire the second signal but still publishes in period 2.

This addition poses some challenges in the tractability of the model because the choice is no longer just between two options and strategies are not necessarily just thresholds in c. However, even in this more complicated setup, we can show a few results. First, for sufficiently low π, it is possible to find values of v such that the equilibrium described in Proposition 4 exists; waiting is never the best response if the other player never waits, and $\sigma_D^* > \sigma_M^*$. Second, we can simulate the model showing that we can assign values to v such that, for the resulting equilibrium σ_D^*, publishing in period 1 is better than waiting and at the same time $\sigma_D^* > \sigma_M^*$.

We begin with the following lemma considering that we are interested in the (candidate) equilibrium strategies described in Proposition 4 where $d^i = wait$ is never played in equilibrium.

Lemma C1 *It is always possible to find off-path beliefs such that, for sufficiently high v, $Eu^i(d^i = wait) \leq Eu^i(d^i = pub)$.*

Proof. Note that $\gamma(W_{\text{II}}, .)$ is off-path in the equilibrium we are considering. For any $\gamma(\varnothing)$ and $\gamma(1)$ as defined above, the expected utility from choosing $d^i = wait$ is

$$\frac{1}{2}\sigma^j \left(\frac{v}{2} + \pi\gamma(\varnothing) + (1-\pi)\gamma(1)\right) + \left(\frac{1}{2}(1-\sigma^j) + \frac{1}{2}\right)(\pi + (1-\pi)\gamma(W_{\text{II}}, .)) \quad \text{(C.1)}$$

On the other hand, the expected utility from publishing immediately is given by

$$\frac{1}{2}\sigma^j\left(v+\gamma(1)\right)+\left(\frac{1}{2}(1-\sigma^j)+\frac{1}{2}\right)\left(\frac{v}{2}+\pi^2(\gamma(\varnothing)-\gamma(1))+\gamma(1)\right) \tag{C.2}$$

Comparing (C.1) and (C.2) and solving for v, we find that $Eu^i(d^i = wait) \leq Eu^i(d^i = pub)$ when

$$v \geq \sigma^j\pi(\gamma(\varnothing)-\gamma(1)) - (2-\sigma^j)\left[\pi^2\gamma(\varnothing)+(1-\pi^2)\gamma(1)-\pi-(1-\pi)\gamma(W_{\text{II}},.)\right] \tag{C.3}$$

Therefore, it is possible to find v and $\gamma(W_{\text{II}},.)$ such that the above condition is satisfied.

■

This makes intuitive sense, as a sufficiently high scoop value should always deter sitting on the information. From now on, we set $\gamma(W_{\text{II}},.) = 0$ and we define $\bar{v} := \sigma^j\pi(\gamma(\varnothing)-\gamma(1)) - (2-\sigma^j)\left[\pi^2\gamma(\varnothing)+(1-\pi^2)\gamma(1)-\pi\right]$.

We can now move to the main proposition.

Proposition C1 *For sufficiently low π, it is possible to find values of v such that the equilibrium described in Proposition 4 exists. In such an equilibrium, waiting is never the best response if the other player follows the equilibrium strategies and $\sigma^*_D > \sigma^*_M$.*

Proof. Suppose that player j always publishes when it is low type and chooses just between publishing or researching when high type. Moreover, suppose that the audience conjectures that both players use the equilibrium strategies described by Proposition 4. For this to be an equilibrium in the new setup, it is sufficient to prove that, given the correct audience's beliefs updating, for every σ, $Eu^i(d^i = wait) \leq Eu^i(d^i = pub)$. To show this, first we prove through Figure 5 that $\frac{\partial \bar{v}}{\partial \pi} > 0$. Moreover, Figure 6 shows that there exists a range of π such that $argmax_\sigma \bar{v}(\pi) = 1$. In the figure, it happens for $\pi \in [.5, .6]$. As a consequence, for every $v \geq \bar{v}(\sigma = 1, \pi \in [0.5, 0.6])$ it is true that, for every σ, $Eu^i(d^i = wait) \leq Eu^i(d^i = pub)$. In other words, if the audience conjectures

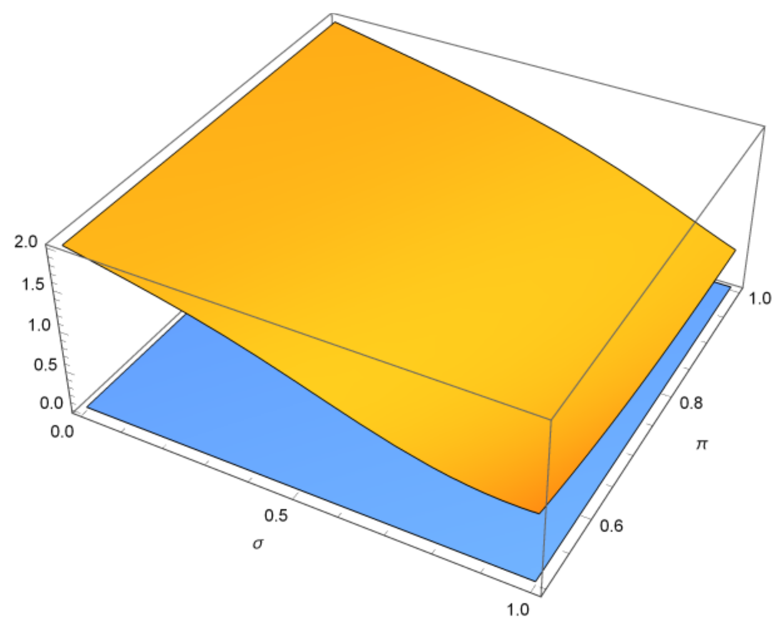

Figure 5: Proof of Proposition C1: Proving $\frac{\partial \bar{v}}{\partial \pi} > 0$. Orange plane: $\frac{\partial \bar{v}}{\partial \pi}$, blue plane: $0.\sigma + 0.\pi$ in the $\pi - \sigma$ space.

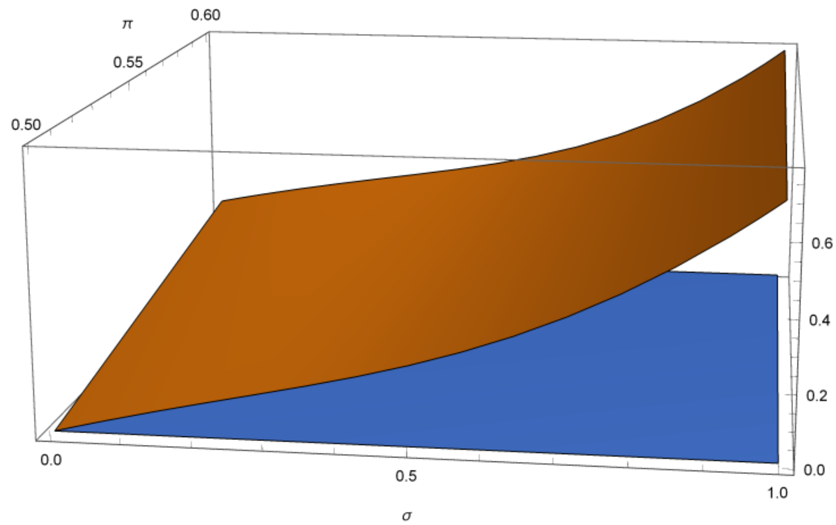

Figure 6: Proof of Proposition C1: Proving $argmax_\sigma \bar{v}(\pi) = 1$. Orange plane: $\bar{v}(\pi)$, blue plane: $0.\sigma + 0.\pi$ in the $\pi - \sigma$ space for $\pi \in [0.5, 0.6]$.

an equilibrium where no types and no players choose to wait, and the choice for the high type is just between publishing and researching described by a threshold strategy on c, behaving in this way is an equilibrium strategy for the outlets.

Finally, Figure 7 plots c_M and $c_D(\bar{v}(\sigma = 1))$ for sufficiently small π, proving that we can still increase v from $\bar{v}(\sigma)$ maintaining the necessary condition for $\sigma_D^* > \sigma_M^*$, i.e. $c_D \geq c_M$. ∎

When $\pi > 0.6$, we can show the existence of our candidate equilibrium through mathematical simulations. Consider, for example the following set of parameters: $\pi = 0.75$, $v = 0.7$, $\bar{c} = 2$, $\varepsilon = 0.1$. In this case, the equilibrium described in Proposition 4 (assuming it still exists) gives a solution $\sigma_D^* = 0.118219$.[19] Suppose now that player i expects player j to never wait and choose to research (if it is high type) with probability 0.118219. Further, suppose the audience thinks that both outlets never wait and research (if they are high types) with probability 0.118219. In this case, $Eu^i(d^i =$

[19]We simulated the model with Mathematica. The code is available upon request.

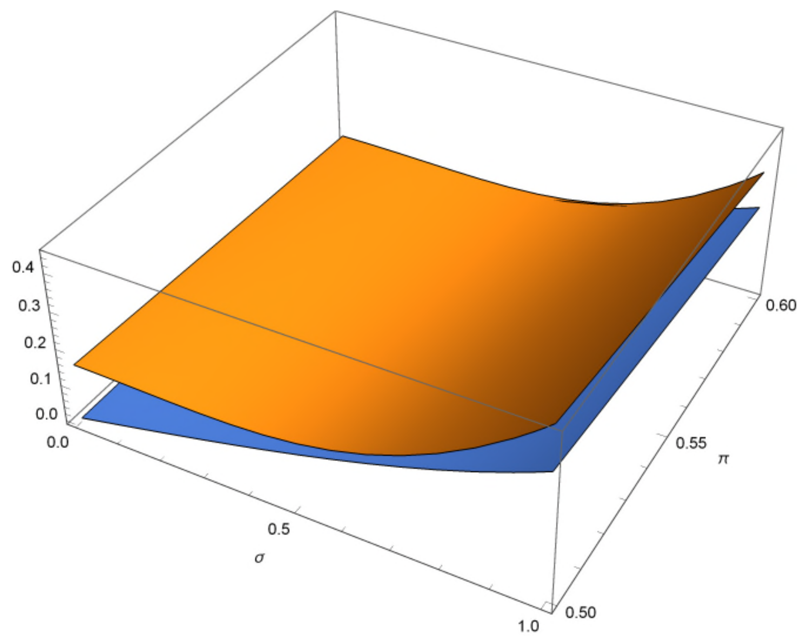

Figure 7: Proof of Proposition C1: Proving $c_D(\bar{v}(\sigma = 1)) > c_M$. Orange plane: $c_D(\bar{v}(\sigma = 1))$, blue plane: c_M in the $\pi - \sigma$ space for $\pi \in [0.5, 0.6]$.

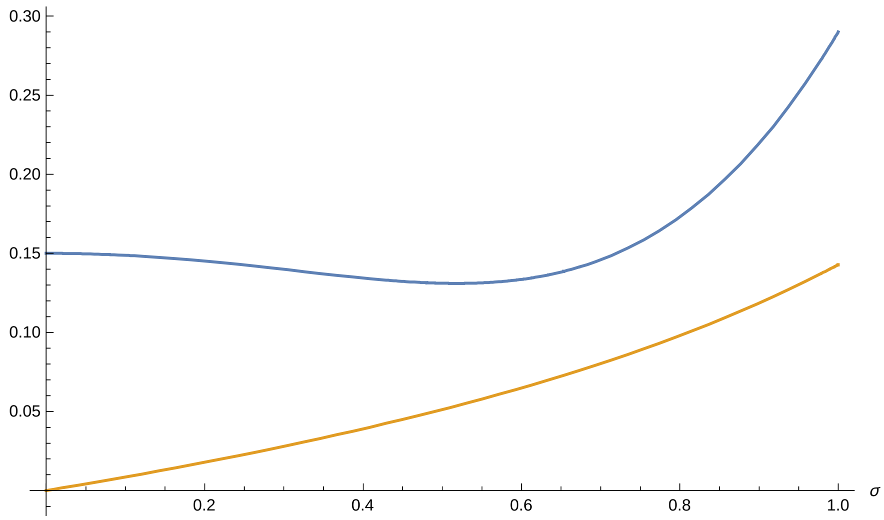

Figure 8: $c_D > c_M$ for $\pi = 0.75$ and $v = 0.7$. Orange line: c_M, blue line: c_D as a function of σ)

$wait) = 0.754218$ and $Eu^i(d^i = pub) = 0.841236$. Hence, there is no incentive to choose to wait instead of publishing, and the meaningful choice is just between researching and publishing. The solution to this problem is the same as that described by Proposition 4. Finally, Figure 8 shows that, for $\pi = 0.75$ and $v = 0.7$, it is still true that $c_D \geq c_M$ for every σ. More generally, Figure 9 plots c_M and c_D (in the $\pi - \sigma$ space) by replacing v with the corresponding $\bar{v}$. Still, c_D is above c_M throughout the entire range of parameters of our model.

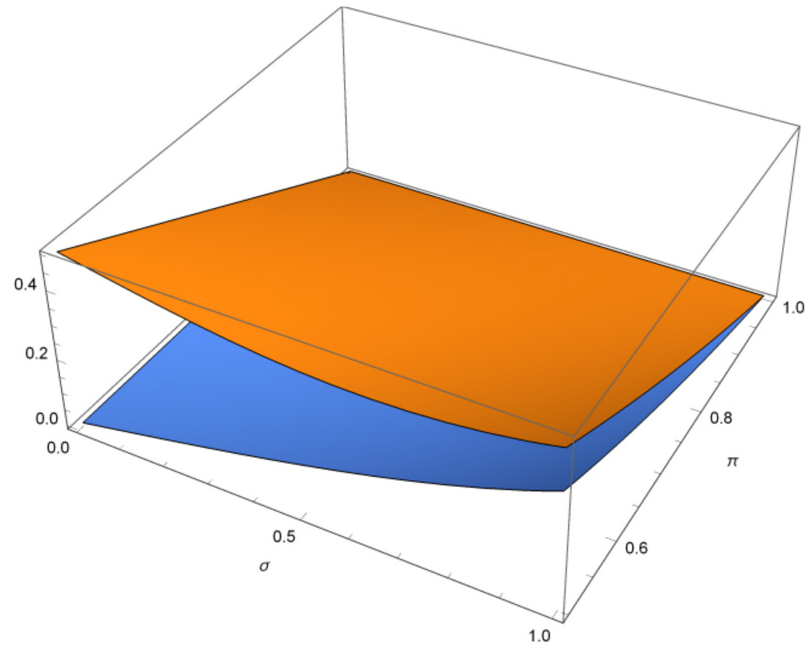

Figure 9: $c_D(v = \bar{v} > c_M$ for every combination of σ and π. Orange plane: $c_D(v = \bar{v})$, blue plane: c_M in the $\pi - \sigma$ space.

D Generic prior on the type

This appendix shows that our main results are qualitatively unaffected by the assumption of prior $\Pr(\theta^i = h) = \frac{1}{2}$. In this section, we assume a generic prior $\Pr(\theta^i = h) = q \in (0, 1)$, leaving the rest of the model unchanged. We consider monopoly, duopoly, and their comparison for when θ is unknown to the reader.

Monopoly

The proposition of the main result is unchanged in monopoly, as q enters only in the readers' beliefs updating.

Proposition D1 *If there is one media outlet and θ is not known to the audience, there exists a unique equilibrium in which the high outlet conducts research in $t = 1$ if and* *only if*

$$c \leq (1-\pi)(\gamma(R)-\gamma(W)) := c_M$$

where $\gamma(R)$ *and* $\gamma(W)$ *are the audiences' beliefs about the outlet's quality after it gets the state right and wrong respectively. As a consequence,* $\sigma^* = F(c_M(q)) = \frac{c_M(q,\sigma^*)+\varepsilon}{\bar{c}+\varepsilon}$.

Proof. Suppose that a high outlet chooses $d = res$ with probability σ. Reminding ourselves from the main text that by Bayes' rule,

$$\gamma(R) = \frac{q(\sigma+(1-\sigma)\pi)}{q(\sigma+(1-\sigma)\pi)+(1-q)\pi}$$

$$\gamma(W) = \frac{q(1-\sigma)(1-\pi)}{q(1-\sigma)(1-\pi)+(1-q)(1-\pi)} = \frac{q(1-\sigma)}{1-q\sigma}.$$

A high quality optimally chooses res if

$$\gamma(R) - c \geq \pi\gamma(R) + (1-\pi)\gamma(W) \implies c \leq (1-\pi)(\gamma(R)-\gamma(W)) := c_M(q)$$

In equilibrium the conjectured σ must be equal to the actual one, hence it must be that

$$\sigma^* = F(c_M(q,\sigma^*)). \tag{D.1}$$

We need to check if such a fixed point exists. To do so, three observations are in order. First, note that both the LHS and RHS of the above are continuous in σ^*. Second, LHS$(\sigma^*=0) = 0 <$ RHS$(\sigma^*=0) = \frac{\varepsilon}{\bar{c}+\varepsilon}$ (as $c_M(q)=0$ at $\sigma^*=0$). Third, LHS$(\sigma^*=1) = 1 >$ RHS$(\sigma^*=1) = F\left(\frac{(1-\pi)q}{q+(1-q)\pi}\right)$, so the equilibrium is the solution of $\sigma^* = \frac{c_M(q,\sigma^*)+\varepsilon}{\bar{c}+\varepsilon}$ and LHS and RHS must cross at least once.

Finally, we need to check for the uniqueness of the fixed point. To show this, it is sufficient to prove that the derivative of the RHS with respect to σ is smaller than 1.

Note that

$$\frac{\partial \text{RHS}}{\partial \sigma^*} = \frac{1-\pi}{\bar{c}+\varepsilon}\left[\frac{\pi(1-\pi)q(1-q)}{(q(\sigma+(1-\sigma)\pi)+(1-q)\pi)^2} + \frac{q(1-q)}{(1-q\sigma^*)^2}\right] > 0$$

Moreover, we can rewrite the equation as

$$\frac{\partial \text{RHS}}{\partial \sigma^*} = \frac{(1-\pi)q(1-q)}{\bar{c}+\varepsilon}\left[\frac{\pi(1-\pi)}{(q(\sigma+(1-\sigma)\pi)+(1-q)\pi)^2} + \frac{1}{(1-q\sigma^*)^2}\right].$$

It is easy to see that, in the range of parameters of the model, $(1-\pi)q(1-q) \leq \frac{1}{8}$; $\frac{\pi(1-\pi)}{(q(\sigma+(1-\sigma)\pi)+(1-q)\pi)^2} \leq 1$ because $\pi(1-\pi)$ is at most $\frac{1}{4}$ and $q(\sigma+(1-\sigma)\pi)+(1-q)\pi$ is at least $\frac{1}{2}$ (when $\sigma = 0$ and $\pi = \frac{1}{2}$); $\frac{1}{(1-q\sigma^*)^2} \leq 1$. As a consequence,

$$\frac{\partial \text{RHS}}{\partial \sigma^*} < \frac{1}{8}\left[1+1\right] < 1$$

and this completes the proof. ∎

Duopoly

For the case of duopoly, we look directly at symmetric equilibria, showing that there exists a unique symmetric equilibrium.

Proposition D2 *If there are two media outlets and θ is not known to the audience, there exists a unique symmetric equilibrium where $\sigma^{i*} = \sigma^{j*} := \sigma^* = F(c_D(q))$ such that*

$$c_D(q) = \left[\left(\gamma(\varnothing) - \gamma(1)\right)\left(q\sigma^* - (1-q\sigma^*)\pi^2\right) + 1 - q\right] - \frac{1}{2}\upsilon$$

where $\gamma(\varnothing) = \frac{q((\sigma^*)^2 q + (1-\sigma^*)(1-q\sigma^*)\pi^2)}{(q\sigma^*)^2 + (1-q\sigma^*)^2\pi^2}$ and $\gamma(1) = \frac{q(1-\sigma^*)}{1-q\sigma^*}$.

Proof. We focus directly on symmetric equilibria where each high outlet uses a threshold strategy on c in the decision on whether to publish or investigate. Define σ as the probability (from the point of view of the other players) that a high outlet chooses to do research. For the same logic as in Proposition 4, the threshold is given by

$$c^i \leq \left[(\gamma(\varnothing) - \gamma(1))\,(q\sigma - (1-q\sigma)\pi^2) + (1-q\sigma)\,(1-\gamma(1))\right] - \frac{1}{2}v := c_D(q) \qquad \text{(A.5)}$$

where, by Bayes' rule, $\gamma(\varnothing) = \frac{q(\sigma^2 q + (1-\sigma)(1-q\sigma)\pi^2)}{q^2\sigma^2 + (1-q\sigma)^2\pi^2}$ and $\gamma(1) = \frac{q(1-\sigma)}{1-q\sigma}$.

Given that cost is uniformly distributed in $[-\varepsilon, \bar{c}]$ and that in equilibrium the conjectured probability of investigation must be equal to the actual one, the (symmetric) equilibrium level of σ, if it exists, must be the solution of

$$\sigma = F(c_D(q, \sigma)) \qquad \text{(D.2)}$$

where

$$F(c_D(q,\sigma)) = \begin{cases} 0 & c_D(q,\sigma) < -\varepsilon \\ \frac{c_D(q,\sigma)+\varepsilon}{\bar{c}+\varepsilon} & -\varepsilon \leq c_D(q,\sigma) \leq \bar{c} \\ 1 & c_D(q,\sigma) > \bar{c} \end{cases}$$

and

$$f(c_D(q,\sigma)) = \begin{cases} 0 & c_D(q,\sigma) < -\varepsilon \\ \frac{1}{\bar{c}+\varepsilon} & -\varepsilon \leq c_D(q,\sigma) \leq \bar{c} \\ 0 & c_D(q,\sigma) > \bar{c} \end{cases}$$

Note that:

1. The LHS of equation (D.2) is linear, with a slope equal to 1, starting at 0 and ending at 1;

2. RHS($\sigma = 0$) ≥ 0 =LHS($\sigma = 0$);

3. RHS($\sigma = 1$) < 1 =LHS($\sigma = 1$);

4. Both LHS and RHS are continuous in σ.

Hence, they cross at least once and there is at least one solution to this fixed point problem.

To show uniqueness, we can rewrite $c_D(q)$ as

$$c_D = AE + 1 - q - \frac{1}{2}v$$

where $A := \gamma(\varnothing) - \gamma(1) = \frac{q^2(1-q)}{(1-q\sigma)[q^2+\pi^2 B^2]}$, $B := \frac{1-q\sigma}{\sigma}$ and $E := q\sigma - (1-q\sigma)\pi^2$. It is easy to see that $\frac{\partial E}{\partial \sigma} \geq 0$. Moreover, it is also true that $\frac{\partial A}{\partial \sigma} \geq 0$. To see this, note that

$$\frac{\partial A}{\partial \sigma} = \frac{-q^2(1-q)\left[-q(q^2+\pi^2 B^2) + 2\pi^2 B \frac{\partial B}{\partial \sigma}(1-\sigma q)\right]}{((1-q\sigma)\left[q^2+\pi^2 B^2\right])^2} \geq 0$$

because $\frac{\partial B}{\partial \sigma} \leq 0$. However, the sign of E is ambiguous, with $E < 0$ for $\sigma < \frac{\pi^2}{q(1+\pi^2)} := \sigma^T$. We claim that the following two conditions are sufficient for uniqueness:

1. $\frac{\partial c_D(q)}{\partial \sigma} \leq 1$ for $\sigma \leq \sigma^T$;

2. $\frac{\partial^2 c_D(q)}{\partial \sigma^2} \geq 0$ for $\sigma \geq \sigma^T$;

The argument is as follows: as RHS$(\sigma = 0) \geq 0 =$LHS$(\sigma = 0)$ and RHS$(\sigma = 1) < 1 =$LHS$(\sigma = 1)$, the fixed point is:

1. Only at $\sigma = 0$, as RHS$(\sigma = 0) =$RHS$(\sigma = \sigma^T)$ and below that in between. Moreover, there cannot be any additional crossing point above σ^T because the RHS would be coming from below, and, as it is convex, it cannot be that they cross and RHS$(\sigma = 1) < 1 =$LHS$(\sigma = 1)$.

2. If the solution is not at 0, the first time they cross it must be that the LHS comes from below. There are two sub-cases:

   - If the first crossing point is in $\sigma \leq \sigma^T$, then there cannot be others in the same interval as $\frac{\partial c_D(q)}{\partial \sigma} \leq 1$. Moreover, there cannot be any other crossing point above σ^T because the RHS would be coming from below, and, as it is convex, it cannot be that they cross and RHS($\sigma = 1$) $< 1 =$LHS($\sigma = 1$).

- If the first crossing point is above σ^T, it must be unique as a second solution would violate RHS($\sigma = 1$) $< 1 =$LHS($\sigma = 1$).

We now prove that the two sufficient conditions outlined above apply to our model.

First, a sufficient condition for $\frac{\partial c_D(q)}{\partial \sigma} \leq 1$ for $\sigma \leq \sigma^T$ is $\frac{\partial E}{\partial \sigma} A \leq 1$. This implies $(1+\pi^2)q^3(1-q) \leq (1-q\sigma)(q^2+\pi^2 B^2)$. As the RHS is decreasing in σ, this condition must hold for the highest possible σ, i.e. for $\sigma = \sigma^T$. Substituting and simplifying, this requires $q(1-q) \leq \frac{1}{\pi^2(1+\pi^2)}$. The LHS is at most $\frac{1}{4}$ while the RHS is at least $\frac{1}{2}$, hence the condition is always satisfied.

Second, a sufficient condition for convexity of $c_D(q)$ for $\sigma \geq \sigma^T$ is $\frac{\partial^2 A}{\partial \sigma^2} \geq 0$. To show that it is always the case, note that

$$\frac{\partial^2 A}{\partial \sigma^2} = -q^2(1-q)\frac{\frac{\partial^2 D}{\partial \sigma^2}D^2 - 2D\frac{\partial D}{\partial \sigma}^2}{D^4} \tag{D.3}$$

where $D = (1-q\sigma)\left[q^2+\pi^2 B^2\right]$, $\frac{\partial D}{\partial \sigma} = -q(q^2+\pi^2B^2) + \pi^2 2B\frac{\partial B}{\partial \sigma}(1-\sigma q) < 0$ and $\frac{\partial^2 D}{\partial \sigma^2} = -q\pi^2 2B\frac{\partial B}{\partial \sigma} + 2\pi^2\left[\left(\frac{\partial B}{\partial \sigma}^2 + \frac{\partial^2 B}{\partial \sigma^2}B\right)(1-\sigma q) - qB\frac{\partial B}{\partial \sigma}\right] > 0$. A sufficient condition for (D.3) to be positive is $2\frac{\partial D}{\partial \sigma}^2 \geq \frac{\partial^2 D}{\partial \sigma^2}D$.

By substitution, this implies

$$\begin{gathered}
2\left[-q(q^2\sigma^2+\pi^2(1-q\sigma)^2)\frac{1}{\sigma^2} - 2\pi^2\frac{(1-q\sigma)^2}{\sigma^3}\right]^2 \geq \left[q\pi^2 2\sigma\frac{(1-q\sigma)}{\sigma^4} + 2\pi^2(1-q\sigma)\frac{1}{\sigma^4} + \frac{4(1-q\sigma)^2}{\sigma^4}\pi^2 + 2q\pi^2\sigma\frac{(1-q\sigma)}{\sigma^4}\right](1-q\sigma)(q^2+\pi^2 B) \\
\sigma^2\left[-q(q^2\sigma^2+\pi^2(1-q\sigma)^2) - 2\pi^2\frac{(1-q\sigma)^2}{\sigma}\right]^2 \geq 3\pi^2(1-q\sigma)^2(q^2\sigma^2+\pi^2(1-q\sigma)^2) \\
\sigma^2 q^2(q^2\sigma^2+\pi^2(1-q\sigma)^2)^2 + 4\pi^4(1-q\sigma)^4 + 4\pi^2(1-q\sigma)^2 q\sigma(q^2\sigma^2+\pi^2(1-q\sigma)^2) \geq 3\pi^2(q^2\sigma^2+\pi^2(1-q\sigma)^2)(1-q\sigma)^2
\end{gathered} \tag{D.4}$$

where the second line follows by the multiplication of both sides by σ^4 and the third by dividing both sides by 2 and working out explicitly the square on the LHS. Note that σ and q always appear together in the last line of (D.4). As a consequence, we can

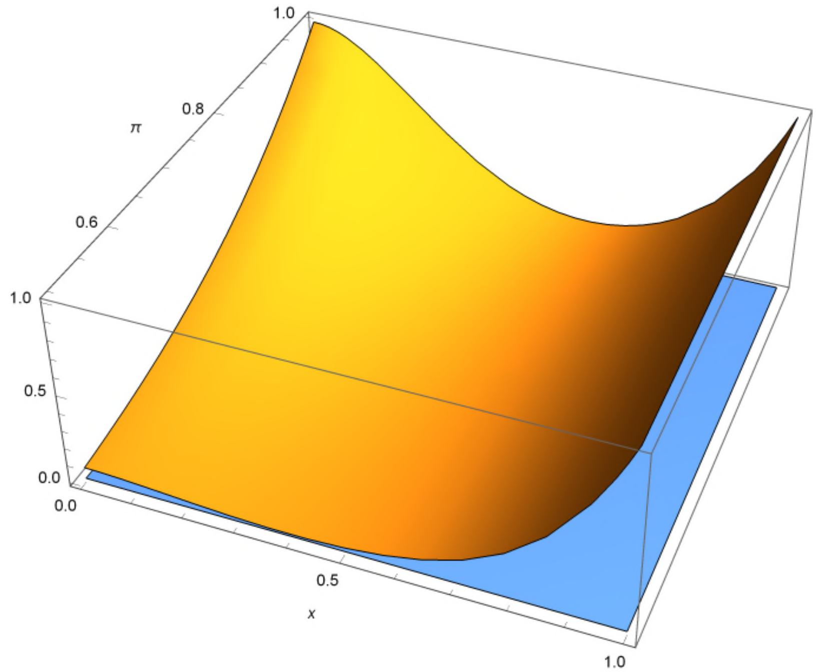

Figure 10: Proof of Proposition D2: Proving LHS > RHS in (D.4). Orange plane: LHS−RHS, blue plane: $0 * x + 0 * \pi$ in the $\pi - x$ space.

redefine $\sigma q := x$ and check whether the condition holds for $x \in [0, 1]$ and $\pi \in [0.5, 1]$. We prove this graphically using figure 10. It plots the difference between LHS and RHS of (D.4) for the whole range of possible values of x and π, showing that this difference is always positive. This completes the proof. ■

Monopoly-Duopoly comparison

Finally, we show that sufficient conditions for competition leading to more research than monopoly can be found in this setup as well.

Proposition D3 *There exists a nonempty interval of v values where $\sigma_D^*(q) > \sigma_M^*(q)$.*

Proof.

A sufficient condition for the proposition to hold is that for some values of v,

$c_D(q) > c_M(q)$. Setting $v = 0$, and defining $B = \frac{1-q\sigma}{\sigma}$ note that:

$$\begin{aligned}
c_D(q) &= (\gamma(\emptyset) - \gamma(1))(q\sigma - (1-q\sigma)\pi^2) + 1 - q \\
&= q\sigma \frac{q^2(1-q)}{(1-q\sigma)(q^2+\pi^2B^2)} - \pi^2(1-q\sigma)\frac{q^2(1-q)}{(1-q\sigma)(q^2+\pi^2B^2)} + 1 - q \\
&= (1-q)\left(\frac{q^3\sigma}{(1-q\sigma)(q^2+\pi^2B^2)} - \frac{\pi^2q^2}{q^2+\pi^2B^2} + 1\right) \\
&= (1-q)\left(\frac{q^2+(1-q\sigma)\pi^2B^2}{(1-q\sigma)(q^2+\pi^2B^2)} - \frac{\pi^2q^2}{q^2+\pi^2B^2}\right) \\
&= \frac{1-q}{1-q\sigma}\left(\frac{q^2+(1-q\sigma)\pi^2B^2}{(q^2+\pi^2B^2)} - \frac{\pi^2q^2(1-q\sigma)}{q^2+\pi^2B^2}\right)
\end{aligned} \tag{D.5}$$

where the first equality follows by substitution and the rest is a series of rearrangements. Note that, as $q \in (0,1)$, neither $1-q$ nor $1-q\sigma$ are ever 0. Similarly, by substitution,

$$\begin{aligned}
c_M(q) &= (1-\pi)\left(\frac{q(\sigma+(1-\sigma)\pi}{q\sigma+q(1-\sigma)\pi+(1-q)\pi)} - \frac{q(1-\sigma)}{1-q\sigma}\right) \\
&= (1-\pi)q\left(\frac{\sigma+(1-\sigma)\pi}{q\sigma(1-\pi)+\pi} - \frac{1-\sigma}{1-q\sigma}\right) \\
&= \frac{(1-\pi)q\sigma(1-q)}{(1-q\sigma)(q\sigma(1-\pi)+\pi)}
\end{aligned} \tag{D.6}$$

As a consequence, by comparison of (D.5) and (D.6), $c_D(q) > c_M(q)$ implies

$$\frac{q^2+(1-q\sigma)\pi^2(B^2-q^2)}{(q^2+\pi^2B^2)} > \frac{(1-\pi)q\sigma}{(q\sigma(1-\pi)+\pi)} \tag{D.7}$$

Note that both LHS and RHS of (D.7) are decreasing in π. The case of RHS is straightforward. For the LHS, a sufficient condition is

$$(1-\sigma q)2\pi(B^2-q^2)(q^2+\pi^2B^2 - 2\pi B^2(q^2+(1-q\sigma)\pi^2(B^2-q^2)) < 0$$

This simplifies to $-\sigma q 2\pi q^2 B^2 - (1-\sigma q)2\pi q^4$ that is always negative.

As a consequence, a sufficient condition for $c_D(q) > c_M(q)$ is LHS($\pi = 1$) >RHS($\pi = 0.5$). By substitution, this implies

$$\frac{q^2 + (1-q\sigma)(B^2 - q^2)}{(q^2 + B^2)} > \frac{q\sigma}{1+q\sigma}$$

After few simplifications and substituting back the value of B, we obtain

$$\sigma^2 q^2 \frac{2q\sigma - 1}{\sigma^2} + \frac{(1-q\sigma)^3}{\sigma^2} > 0$$

A sufficient condition for this to hold is

$$1 - 3q\sigma + 2q^2\sigma^2 + q^3\sigma^3 > 0$$

Noticing that $q\sigma$ is bounded between 0 and 1, the condition is always satisfied and this completes the proof. ■

E Monopoly with public signal

In this appendix, we assume that the audience learns the actual timing with positive probability z in monopoly. This helps us establish that additional learning in our benchmark duopoly model happens not only because the timing is revealed with some probability but also because the audience uses additional information from outlets matching the state. In this setup, the outlet does not know whether the audience has learned the timing or not when taking its decision. Then, the condition for doing research is

$$z\gamma_M(2) + (1-z)\gamma_M(\varnothing) - c \geq z\gamma_M(1) + (1-z)(\pi\gamma_M(\varnothing) + (1-\pi)\gamma_M(1)) \tag{E.1}$$

Note that $\gamma_M(2) = \gamma(2) = 1$ and $\gamma_M(1) = \gamma(1) = \frac{1-\sigma}{2-\sigma}$. However,

$$\gamma_M(\varnothing) = \frac{\sigma + (1-\sigma)\pi}{\sigma + (1-\sigma)\pi + \pi} \neq \gamma(\varnothing) = \frac{\sigma^2 + (1-\sigma)(2-\sigma)\pi^2}{\sigma^2 + (2-\sigma)^2\pi^2}$$

because in a duopoly the audience can learn also from the other player getting the state wrong. Hence, the audience is confused only if both outlets publish simultaneously and they both get the state right.

For comparison, we can write the duopoly condition for $v = 0$ a bit differently. Define χ the probability that the opponent behaves in a way that reveals the timing to the reader. Note that χ is "artificial" because it is the probability that j does not research when player i does (i.e. $\frac{1}{2}(1-\sigma^j) + \frac{1}{2}$ on the LHS) and vice-versa (i.e. $\frac{1}{2}\sigma$ on the RHS). In such cases, the action of player j is fully revealing of the timing, irrespective of the endorsement. The duopoly condition for research is then

$$\chi\gamma(2) + (1-\chi)\gamma(\varnothing) - c \geq \chi\gamma(1) + (1-\chi)(\pi^2\gamma(\varnothing) + (1-\pi^2)\gamma(1)) \tag{E.2}$$

Comparing (E.1) and (E.2) reveals that they are similar, but not identical. Even if we set $z = \chi$, the difference in $\gamma(\varnothing)$ and in the π^2 term of the RHS is still there. Hence, our result is not just due to the fact that the publication timing of the opponent reveals information about the timing of the other player. The content of the endorsements plays a role as well.

F Knobel (2018) results on watchdog reporting

Table 1: Deep (first row) and simple (second row) accountability reporting (as a % of total front-page stories in April) in a sample of 9 newspapers in the US for 1991-2011 in five-year gaps

Newspaper group	Newspaper	1991	1996	2001	2006	2011	Average
Large	*Wall Street Journal*	1.28	2.33	5.88	5.26	4.85	4.03
		30.77	22.09	23.53	22.11	27.18	25.06
	Washington Post	1.51	3.55	4.23	2.72	7.74	3.80
		25.63	27.41	31.92	37.50	36.13	31.43
	New York Times	0.34	0.93	4.35	5.43	3.19	2.46
		10.51	9.29	18.26	19.57	28.72	15.82
Metropolitan dailies	*Albany Times Union* (NY)	6.35	1.22	3.45	4.12	3.61	3.64
		47.62	23.17	28.74	17.53	36.14	26.37
	Denver Post	0.00	4.85	1.80	3.06	5.13	2.92
		23.33	22.33	28.83	29.59	43.59	28.96
	Minneapolis Star Tribune	2.46	1.15	1.83	2.86	5.00	2.68
		31.97	36.78	22.02	34.29	41.00	32.89
	Atlanta Journal-Constitution	1.20	0.00	1.06	1.75	11.84	2.30
		14.97	11.11	13.30	30.70	48.68	20.52
Small	*Bradenton Herald* (FL)	0.93	1.61	1.14	1.27	1.44	1.26
		19.44	33.87	32.95	21.52	19.42	24.16
	Lewiston Tribune (ID)	0.00	0.00	0.00	0.00	1.45	0.32
		22.22	15.25	40.74	28.33	23.19	25.80
Average		1.26	1.81	2.92	3.25	4.46	2.69
		21.52	19.78	24.46	27.26	32.59	24.94

Source: *The Watchdog Still Barks: How Accountability Reporting Evolved for the Digital Age.* Knobel (2018). The author analyzed the content of every front-page story that was published in the month of April (randomly selected) in five-year gaps starting 1991 in a select sample of 9 newspapers. The stories chosen for deep and simple categories involved the following procedure. First, the author eliminated stories that were breaking news. Second, she eliminated stories that had no relation to public policy or politics. In all, she analyzed 1,491 stories in depth using content analysis. Simple accountability reports/stories are those that took a few hours or days to complete, relying on straightforward reporting such as interviews or reviewing published documents. Deep accountability reports/stories are those that took weeks or months to develop and would have remained secret without the journalists' work.

We show in Table 1 the data from Knobel's study in support of our theoretical results. Her study paints a more positive image of the future of watchdog reporting. While not exactly the same as reporting accurate stories, watchdog reporting, which includes investigative journalism and fact-checking, takes time. The table shows an increasing share of accountability reporting among a sample of 9 US newspapers for 1991-2011. In particular, note how there is an increase in accountability reporting across categories since 2006. Note that by 2006 the broadband penetration rate in the USA was already 20.23 broadband subscriptions per 100 people (See this link). The increase is visible for both deep and simple accountability reporting, and across newspaper groups. While the increase may be due to several reasons, her data together with the interviews hint at a similar path to that which we outline in this paper.