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The newsroom dilemma

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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. Two opposing forces determine the resolution of the speed-accuracy tradeoff: preemption and reputation. Although competition exacerbates preemption concerns, it provides additional information to the audience by allowing them to compare publication times. Hence, more competitive environments may be more conducive to reputation building, which may lead to better reporting. However, we show that the audience may be worse off due to the outlets' better initial information.

KEYWORDS
media competition, preemption, reputation

JEL CLASSIFICATION
D43, D83, L82

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 hinted 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, damaging the New York Post's credibility. 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%.

Media critics often cite such examples to argue that competitive pressures in the modern digital environment have pushed outlets toward 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 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." Similarly, some media scholars argue that the fears surrounding the effect of competition may be overblown (Carson, 2019; Knobel, 2018).

Abbreviations: BBC, British Broadcasting Corporation; PBNE, Perfect Bayesian Nash Equilibrium; R&D, research and development.
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This paper discusses why competition among media outlets might not prioritize speed over accuracy. We also consider the implications of competition on audience welfare and information dissemination. We argue that two opposing forces—preemption and reputation—determine the resolution of the speed-accuracy tradeoff. We show that competition, while inducing preemptive motives, can also increase the information available to the reader, leading to stronger reputational incentives for better reporting.

We build a two-period model in which two career-concerned media outlets compete against each other and fear preemption. There is a topic on which the outlets can publish stories. Both outlets receive an initial informative signal on the topic. They may further investigate the topic at a cost that depends on their ability. We model research as generating a perfectly informative signal about the topic. A scoop value accrues to the first outlet to publish a story on the topic. In addition to valuing scoops, outlets also care about their reputations, which depend upon an audience's inference about the outlet's ability to research. Notably, the audience makes inferences based on publication sequence rather than publication time.

Our model yields two main results that speak to the changes in the media landscape brought about by the Internet. The Internet has reduced barriers to entry and contributed to a 24-h news cycle where reporters are always on deadline (Lee, 2014; Starbird et al., 2018). 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 make outlets research stories more thoroughly. We show 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, this result relies upon the arguably realistic assumption that the audience observes only which outlet publishes first, not the time they spend researching. Knowing the sequence of publications rather than the amount of research allows additional observational learning in a competitive environment. Consequently, it gives better outlets a reason to differentiate when faced with competition. To our knowledge, this result is new to the literature, primarily focused on the increased preemptive pressure induced by 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 initial signal quality without changing the research cost.

We find that a *better* initial signal can *reduce* the welfare of the audience. To show this result, we begin by adding more structure to the audience's preferences. We posit that there is a decision to make, and two audience types populate the readership: the first values quick decision-making over the correct one, the urgent audience, and the second values correct decision-making over a quick one, non-urgent or patient audience. When the initial signal becomes more precise, the audience attributes correct information by the media outlets to the better signal rather than their ability to conduct in-depth research. Thus, reputational concerns get diluted, and timing pressures become more salient, making the media outlets move toward speed. If the audience values better reporting sufficiently, that is, an average audience member is more likely to be patient, 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 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, as the competitive pressure to preempt the other outlet may be dominated by the desire to build a reputation (and the increased possibility to do so).

Stylized facts from practitioners and media studies. The speed versus accuracy tradeoff is commonly recognized in the media studies literature. The BBC guidelines clearly state that "In news and current affairs content, achieving due accuracy is more important than speed."[3]

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The terms of this tradeoff hinge on the surrounding environment. The literature highlights two critical determinants of the rise of "speed-driven journalism" in the modern digital environment. The first one is increasing competitive pressure. 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" (Barber, 2017).[4] Thus, outlets cannot only count on their preexisting reputation to attract readers, and being the first to break the news is increasingly important. Rosenberg and Feldman (2008) note, "Why do experienced journalists telecast unscreened material in volatile situations? Because they can, and because they are driven by powerful, rush-to-report hard instinct, the one commanding them to beat or at least keep astride of the competition and not be left behind."

The second is the 24-h news cycle (Lee, 2014; Starbird et al., 2018), which leads to the possibility of being preempted at any point in time. Newspapers used to have editions, making it possible to verify information until the night before publication, almost without fear of someone else breaking the news. That is no longer the case. As Howard Kurtz from *Washington Post* describes, "In the last year, the pendulum has swung in our newsroom to putting things on the Web almost immediately [...] everybody wants it now-now-now. [...] But the sacrifice (clearly) is in the extra phone calls and the chance to briefly reflect on the story that you are slapping together" (Rosenberg & Feldman, 2008).

Importantly, however, increased pressures toward early publication times may not have had the obvious consequence. Knobel (2018), for instance, paints a more positive image of the future of watchdog reporting, which includes time-consuming investigative journalism and fact-checking. Knobel's results show an increasing share of such reporting among a sample of nine US newspapers for 1991–2011, with a marked increase across all newspaper categories since 2006. Interestingly, by 2006, the broadband penetration rate in the USA was already 20.23 broadband subscriptions per 100 people.[5] One reason for such a result may be that reputational concerns have become more salient.

Reuters Handbook of Journalism states "Reuters aims to report facts, not rumors. Clients rely on us to differentiate between fact and rumor, and our reputation rests partly on that" (Reuters, 2008, p. 5). Note that reputation is based on the ability to check the facts before releasing them, which is also how we model it. Knobel summarizes her interviews with the editors by saying they realize readers can be induced to pay for quality journalism. 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." Our motivation to look at reputation-building as a countervailing force to speed-driven journalism is derived from such observations.

Contributions to related literature. Our primary contribution is to the literature studying speed-accuracy tradeoffs in media economics (Andina-Díaz et al., 2019; Andreottola & De Moragas, 2025; Lin, 2014; Oliver, 2022; Shahanaghi, 2021, 2023), to which we introduce Bayesian reputation-building players. Our framework reveals a novel force of additional information for consumers in more competitive environments, aiding reputation building. We believe we are the first to highlight this informational role of competition that affects reputation building and may counterbalance the preemptive effect of increased competition. As a result, we show that competition in monopolistic markets may actually increase the incentives for researching stories, even in cases where research is already happening (with some probability).

Andina-Díaz et al. (2019) also consider a model where outlets compete for scoops, and the type of stories published affects future audiences. However, in contrast to their model, the outlets and the audience are strategic in ours, with the interaction between endogenous Bayesian reputation-building and time pressure for publication driving the results. Thus, differently from them, we study how informational spillovers affect the speed-accuracy tradeoff under competition.

Andreottola and De Moragas (2025) also study how competition alters the speed-accuracy tradeoff media outlets face. In their model, outlets may take time to "fact-check" rumors to attract a sophisticated audience but fear preemption. Our paper differs because outlets in our model are driven to research their stories due to reputational concerns. Thus, a Bayesian payoff structure and audience learning under the ideal information environment are crucial and distinctive features of our model.[6]

Shahanaghi (2021) provides a micro-foundation for the speed-accuracy trade-off in a dynamic model of learning and reporting where the sender is concerned about its reputation. However, it does not deal with the question of the effect of competition as we do. Shahanaghi (2023) applies the framework of Shahanaghi (2021) to a competitive setting, finding that competition exacerbates an already existent incentive to misreport. This is partially mitigated by consumers having a lower trust for stories reported too quickly. Our model produces the opposite result, driven by the audience comparing outlets' reporting times. Doing so provides (potentially) valuable information that, in turn, makes reputationally-concerned outlets more careful. Our distinct result arises from our modeling choice of the nature of information arrival—discrete, finite time and correlated signals, firms building a reputation on their type rather than on whether the story they publish is correct, and observability of time by the readership.

Lin (2014) and Oliver (2022) study the speed-accuracy trade-off but do so 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.

Our paper relates to some new literature that theoretically and empirically explores the effect of the Internet (or, more generically, of new technologies) on the media landscape. Cagé et al. (2019) stress the commercial value of building a reputation for original content in the internet era when there is widespread use of copy and paste between news outlets. In Angelucci and Cagé (2019) the authors show that a drop in the advertising revenues due to television entry in France leads to a smaller newsroom, decrease in prices and a move toward "soft" information. Angelucci et al. (2020) show that television entry in the US reduced readership, advertisement, and original reporting of newspapers. Armstrong (2005) looks at the relative effect of advertising-only with a subscription-based funding mechanism on journalistic quality. Most of these papers and others (Dukes, 2006; Ellman & Germano, 2009; Gentzkow, 2014) build on two-sided market models (Rochet & Tirole, 2003, 2006) and are concerned with pricing decisions, rather than with the speed-accuracy trade off.[7] We do not explicitly model advertising and pricing concerns. Instead, we subsume them under either preemption or reputational concerns.[8]

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.[9] Lastly, Andina-Díaz and García-Martínez (2020) show how reputational concerns may lead media outlets to self-censor or withhold stories, thereby reducing the probability of verification, even under competition. Thus, unlike our case, they look at the adverse impact of reputation-building for consumers.

We also contribute to the literature on strategic information release. We differentiate from Guttman (2010) and Guttman et al. (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. Gratton et al. (2017) look at a model in which a sender strategically releases a stream of information to influence perceptions about herself. They show better sender types release the information earlier and expose themselves to scrutiny. This contrasts with our model, where better outlets release information later. In our model, outlets who give information later are conferred reputational benefits due to preemption concerns arising from competition. In their model, there is no competition, and senders build a reputation by opening themselves up to more scrutiny through the early release of information.

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 & Tirole, 1985), but our paper contributes to the more recent literature on preemption games with private information (Bobtcheff et al., 2016; Hopenhayn & Squintani, 2011, 2015). It is worth noting that Bobtcheff et al. (2016) 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 periods $t = 1, 2$. It features 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. It remains the same in both periods. 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, in $t = 1$, each outlet privately observes a signal s^i about the state of the world. 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

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$\Pr(s = \omega|\omega) = \pi \in (0.5, 1)$. Outlet i's decision d^i at $t = 1$ is to choose between publishing immediately in $t = 1$, *pub*, or doing more research and 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. We focus on equilibria where $m = s$; thus, it would be equivalent to assuming that messages are hard information.

Further research is costly, but it perfectly reveals the true state of the world in $t = 2$, which the firm publishes. In particular, there is a type-specific research cost, which is each outlet's private information. Outlets' type is given by their quality θ^i and their cost of research c^i. Outlets' quality can be high or low, depending on how efficient they are at digging into stories, and this is the private information of each individual outlet. Formally, quality of outlet i is $\theta^i \in \{h, l\}$ with a common prior $\Pr(\theta^i = h) = q = \frac{1}{2}$.[10] The types are independent.

Outlets with quality $\theta = l$ face 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-quality outlet is story-specific private information for that outlet. 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.[11] 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 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. In other words, the audience observes whether outlets publish simultaneously or one after the other, but not whether they do so in period 1 or period 2. The sequence is denoted by $\tilde{t}^i \in \{\mathrm{I}, \mathrm{II}, \varnothing\}$, 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. Therefore, the information of the audience $\mathcal{I}$ at the end of the game is denoted by a tuple $\left(O^i_{\tilde{t}}, O^j_{\tilde{t}}\right)$ that consists of four pieces of information, that is, each outlet's position in the publication sequence and the outcomes. The audience updates its beliefs about each outlet's type using $\mathcal{I}$. 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 (if both outlets publish at the same time, each of them gets a scoop value of $\frac{v}{2}$). It captures the preemptive nature of the media market (Besley & Prat, 2006). One may interpret it as the advertising revenue from the audience 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.[12]
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, more structure is 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. Each outlet privately observes θ. 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.
2. The outlets simultaneously decide $d^i \in \{pub, res\}$. 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, equilibria selection and strategies

Our solution concept is the Perfect Bayesian Nash Equilibrium in pure strategies. We focus on equilibria where outlets optimally follow the signal they receive, that is, they endorse the more likely state given their signal, and they choose the same research probability after every signal realization (when high types). We call such equilibria *signal-based* equilibria.[13] For the rest of the paper, we use “equilibrium” and “signal-based equilibrium” interchangeably.

It is helpful to define the strategies on which we will focus our attention. 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.[14] In a symmetric PBNE, the threshold is common to both outlets. 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 $t = 1$, conditional on outlet i being a high type.[15] Therefore,

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

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 publication sequence 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 outside the newsroom. Consequentially, player i's decision to publish or not potentially conveys information about player j's type. For example, if the two outlets move sequentially and only a high type is expected to conduct research, moving later signals the first outlet is likely to be a low type. We show how relaxing this assumption changes our result in Section 3.3.

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 exploring the same story. We assume that both media outlets know their competitor also possesses the story. While we do so for tractability, we stress that this assumption does not drive the results.[16] Knowing that the competitor also has the first signal pushes the incentives of the outlets toward speed because of the preemption concern. Still, it also allows high-quality outlets to signal their type through research.

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 they face different costs when exploring different stories. For instance, *The Wall Street Journal* is a business-centric daily that 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 the outlets to “sit on information” or wait for a period before publishing. Second, we assume that the audience correctly finds the state at the end of the game. Third, we assume the media outlets correctly determine the state when researching. Almost all of these assumptions can be somewhat relaxed without altering our predictions.[17]

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3 | COMPETITION LEADS TO BETTER REPORTING

3.1 | How the newsroom dilemma gets resolved

We start by considering the case of a monopoly outlet.

Proposition 1. *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* $c \le (1-\pi)(\gamma(R) - \gamma(W)) := c_M(\sigma^*)$. *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; ν does not play any role. Proposition 1 then captures the idea that c_M is defined so that the expected reputational gains from endorsing the correct state more than compensate 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

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

from Bayes' rule. The cost threshold, $c_M(\sigma)$, then shows that the reputational gains, $\gamma(R) - \gamma(W)$, 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 $1-\pi$.

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 1 further shows that such a fixed point exists and is unique.

Second, we consider the case of duopoly, where both preemption risk and reputation-building concerns interact. The audience in this situation observes 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 audience uses both pieces of information to update beliefs about the outlets' types in this situation. 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.[18]

Three belief updates can summarize these eight events. These beliefs differ in how much information the audience can infer about the timing of the game and the types of media outlets.

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, that is, both are high types that happen to draw a low cost of research,[19] or if they are publishing without research. 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 both face high (independently drawn) costs. With some abuse of notation, we denote the updated belief here by $\gamma^i(\varnothing)$ to highlight the audience's updated belief about outlet i when it does not know the publication sequence. It is given by

$$\gamma^i(R_\varnothing, R_\varnothing) = \frac{\frac{1}{2}\left[\frac{1}{2}(\sigma^i\sigma^j + (1-\sigma^i)(1-\sigma^j)\pi^2) + \frac{1}{2}(1-\sigma^i)\pi^2\right]}{\frac{1}{2}\left[\frac{1}{2}(\sigma^i\sigma^j + (1-\sigma^i)(1-\sigma^j)\pi^2) + \frac{1}{2}(1-\sigma^i)\pi^2\right] + \frac{1}{2}\left[\frac{1}{2}\pi^2 + \frac{1}{2}(1-\sigma^j)\pi^2\right]}$$

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

1. *Published in period 1 without research*: In the events $\{(R_\varnothing, W_\varnothing), (W_\varnothing, W_\varnothing), (W_\varnothing, R_\varnothing), (R_{\rm I}, R_{\rm II}), (W_{\rm I}, R_{\rm II})\}$ the audience is able to infer that outlet i moved in the first period without research.[20] This happens in a few instances: the presence of a competitor who gets the state wrong when both publish simultaneously or of a competitor who moves afterward 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. Following the same idea from the previous point, we denote the updated belief by $\gamma^i(1)$ in these events, and it equals $\frac{1-\sigma^i}{2-\sigma^i}$.
2. *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, $\gamma^i(R_{\rm II}, R_{\rm I}) = \gamma^i(R_{\rm II}, W_{\rm I}) = 1 := \gamma^i(2)$. Note that these outcomes, as well as the outcomes $(W_{\rm II}, .)$, would be off-path in equilibria with no research. However, given our assumption on the fact that l outlets have an infinite cost of doing research, we select off-path beliefs such that $\gamma^i(R_{\rm II}, .) = \gamma^i(W_{\rm II}, .) = 1$ when $\sigma^i = \sigma^j = 0$.

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

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

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

Using these ideas, we can now identify the nature of equilibria in the duopoly case, captured in Proposition 2 below.

Proposition 2. *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*

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

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

That we obtain a unique equilibrium in Proposition 2, which is also symmetric, is not immediate in our setup. The reason is that the audience cannot observe the outlets' decisions; they can only decipher them from the sequence. So, any equilibrium must be consistent with the audience's conjecture of what the outlets did based on the sequence observed. Accordingly, in equilibrium, it is required that both σ^i and σ^j are solutions to the fixed points of equations $\sigma^i = F\left(c^i_D(\sigma^i, \sigma^j)\right)$ and $\sigma^j = F\left(c^j_D(\sigma^i, \sigma^j)\right)$. Moreover, both strategies must be best responses to each other as the outlets move simultaneously, and each is unaware of the other's type and the realized cost.

To see why the proposition still holds, let us illustrate the fixed point condition by first assuming a symmetric equilibrium, where the equilibrium σ is such that $\sigma^i = \sigma^j := \sigma$. Here, $c_D(.)$ is a function of one variable only, σ, and the equilibrium condition reduces to $\sigma = F(c_D(\sigma))$ (see Figure 1).

The figure shows that for such an equilibrium to exist, $F(c_D(\sigma))$ must intersect at least once the 45°-line. As c_D is smaller than 1 even when a firm is expected to research with probability 1, $F(c_D) < 1$. Moreover, if the scoop value is not too large, $F(c_D) > 0$ even if the firms are not expected to research.[21] Thus, existence is guaranteed.

Nonetheless, it is not straightforward to determine the shape of $F(.)$. Indeed, the right panel shows that $F(c_D(\sigma))$ may cut the 45°-line to produce multiple equilibria. To retrieve uniqueness, we "flatten out" the distribution function

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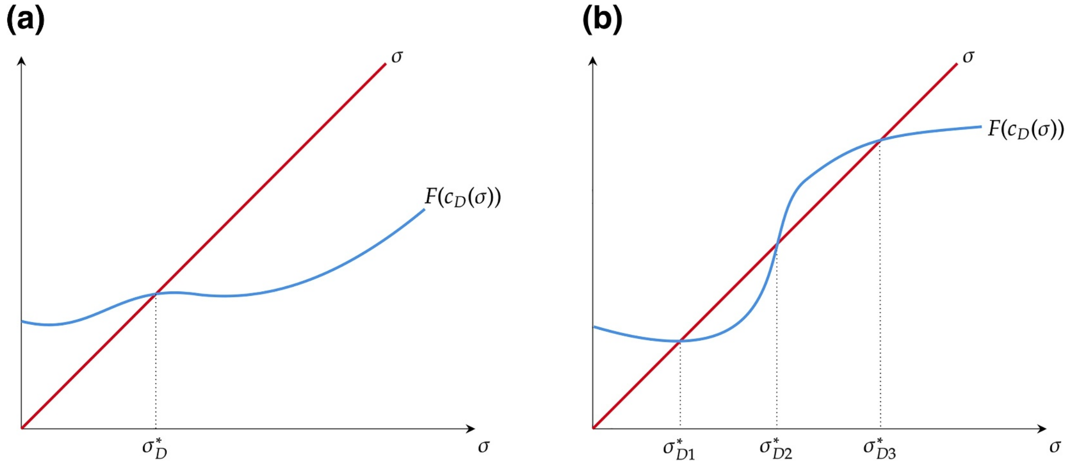

FIGURE 1 Getting a unique internal equilibrium σ^*.

$F(.)$ for *any* σ as in the left panel of Figure 1. Given that F is a uniform distribution, we can achieve so by setting a sufficiently large $\bar{c}$, that is, by increasing the size of the support of the distribution. With a larger support size, the effect of σ on F through c_D is mitigated by making any $c_D(\sigma)$ realization a lower likelihood event. Two is the minimum value of $\bar{c}$ that achieves this purpose. Moreover, this rationale holds even if we focus on asymmetric equilibria. However, going from asymmetric to symmetric equilibrium is immediate since the firms are assumed symmetric to begin with. Thus, we obtain a symmetric and unique equilibrium.

Finally, note that the equilibrium cost threshold $c_D(\sigma^*)$ decreases in v. As research happens whenever the randomly drawn cost is below the threshold, this implies that, as the scoop value increases, the incentive toward speed becomes stronger.

3.2 | Competition may lead to better reporting

The comparison between monopoly and duopoly when reputation building is relevant (Propositions 1 and 2) provides interesting insights.

Lemma 1. *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 make c_D decrease in v (see Proposition 2). The two effects combined yield our first main result about the effect of Internet-driven competition on reporting.

Proposition 3. *There exists a nonempty interval of scoop values, v, where $\sigma_D^* > \sigma_M^*$.*

Proposition 3 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 2. Increasing v parallelly lowers $F(c_D)$ without affecting $F(c_M)$. So, $\sigma_D^* > \sigma_M^*$ for sufficiently small v.

The main point of Proposition 3 is that, contrary to the wisdom of the crowd, competition does not necessarily lead to a faster release of less accurate information.[22]

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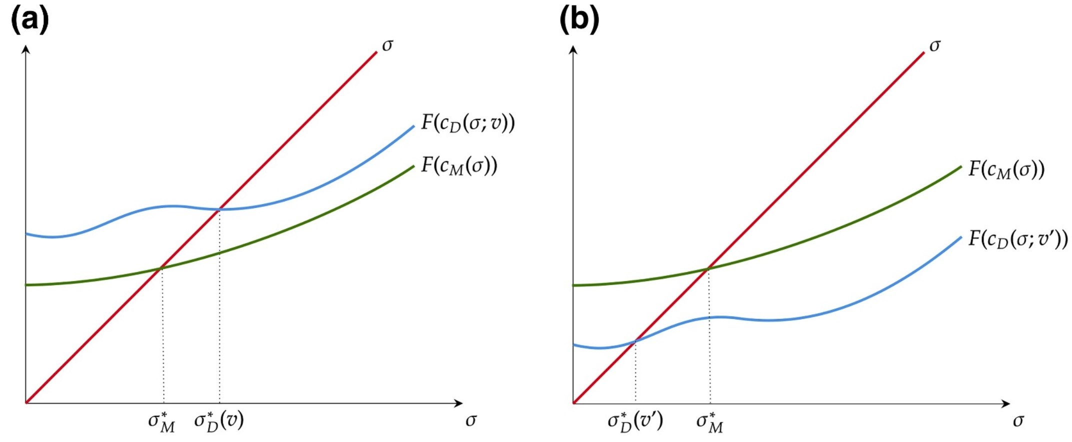

FIGURE 2 Comparing σ_M^* with σ_D^* for a given v.

3.3 | 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, that is, 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 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 the two 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 media market's preemptive nature. If the audience does not understand

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when the publication happened, there is nothing to gain from being first. There are only gains from ultimate publication. 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 differentiation happens on the time dimension rather than on (partially observable) research and the story's truthfulness. Again, this hardly seems true in reality.

4 | STORIES AND THE EFFECT OF BETTER INITIAL INFORMATION

We can now 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

$$V_u = \begin{cases} 1 \text{ if deciding as soon as the news breaks and } \alpha = \omega, \\ 0 \text{ if deciding as soon as the news breaks and } \alpha \neq \omega, \\ -k \text{ for } k > 0 \text{ if remaining undecided or deciding later,} \end{cases}$$

Therefore, "urgent" readers prefer to decide as soon as possible, even if the decision does not match the state of the world, rather than wait. The preference of the patient audience, on the other hand, is given by

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

The patient audience does not care about when it makes the decision; making an accurate decision matters more. So, when only one outlet publishes on-path in an equilibrium where only the high outlets do research, the patient audience always waits for the second publication for any $k > 0$. However, the preferences described by V_{1-u} do not immediately describe what this audience does when both outlets publish together. Specifically, this choice is contingent on k, π, and the equilibrium σ. In what follows, we assume $k > 3$ and $\frac{1}{2} < \pi < \frac{k-1}{k+1}$ so that the patient audience prefers to remain undecided for any (symmetric) equilibrium $\sigma > 0$ when both outlets publish together.[23] As is evident, sufficient conditions require the loss from the wrong decision, k, to be sufficiently large and the probability of the outlet providing the correct information π without research to be small relative to the loss.

u is story-specific, and when the outlets get a story, they also learn the value of u perfectly. 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: the bigger it is, the stronger the incentive to publish the story as soon as possible because this allows to sell it to a bigger audience. Note, however, that there are some critical differences in the payoff structure between this section and the benchmark model of Section 2. First, if outlets publish simultaneously, they no longer split the available market share because a fraction of consumers, namely the patient audience, will not read any story. Second, unlike the benchmark model where the second-mover does not get any non-reputational payoff, in this case, even outlets reporting second receive some audience.

The monopoly case discussed in Proposition 1 remains unchanged. The result of the duopoly case also remains qualitatively unchanged, albeit with a new cost threshold, $\overline{c}_D$, and in the symmetric equilibrium, $\overline{\sigma}^*_D = F\left(\overline{c}_D\left(\overline{\sigma}^*_D\right)\right)$. The precise expressions of these objects are presented in the online appendix A in Supporting Information S1.

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

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Proposition 4. *Let $k > 3$ and $\frac{1}{2} < \pi < \frac{k-1}{k+1}$. Then, there exists a fraction of urgent audience, $\overline{u} \in (0,1)$ such that*

- *for stories with at most $\overline{u}$ fraction of urgent audience, research by high outlets in a duopoly is at least as likely as in monopoly, that is, $\overline{\sigma}_D^* \geq \sigma_M^*$, and*
- *for stories with more than $\overline{u}$ fraction of urgent audience, research by high outlets in a duopoly is less likely than in monopoly, that is, $\overline{\sigma}_D^* < \sigma_M^*$.*

We, therefore, hypothesize that competitive environments are better for research on non-urgent topics. One such example is the 2017 *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. Conversely, 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 assess the audience's welfare. The audience's welfare V under our restricted parameter space is defined as follows

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

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

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 significant effect of the Internet has been to make it easier to conduct preliminary research. Emails and social media make it particularly easy to share pictures, videos, and text from anywhere. 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 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 5. *Let $k > 3$ and $\frac{1}{2} < \pi < \frac{k-1}{k+1}$. Then, there exists an interior u, $\overline{u}^V \in (0,1)$, such that if the story has less than $\overline{u}^V$ 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 as follows. 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 comprises more patient types, that is, u is low.

5 | INFORMATION DISSEMINATION BY A STRATEGIC SOURCE

We now turn back to our original model and use it to determine how a strategic source with a desire to get a story published quickly, that is, in $t = 1$, can share her signal with media outlets. The motivation to study this problem is driven by the observation that political actors are often interested in highlighting their achievements or bringing out potentially damaging information about their competitors as quickly as possible. X (formerly 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. We suppose that such a source gets a payoff of 1 if the story is published in $t = 1$ and 0 otherwise.

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We aim to determine whether the source wants to share her signal with one or both outlets to fulfill her objective. In line with our model, we will assume that if the source shares a story with both outlets, both know 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 of the story and the former outlet knows so.[24] Moreover, we assume that the ex-post verification of the readers includes information on whether a story was received. Therefore, when the reputation of each outlet is determined, the reader also knows (and takes into account) who received the signal.

These assumptions allow the outlet with a story, if it is the only one receiving it, 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. As the source is the same, both outlets are receiving the same story. Therefore, unlike the benchmark model, the probability that they both have the correct signal is π, rather than π^2. The source decides who to share the story with at the beginning of the game, say in 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. The rest of the model is unchanged.[25]

Our central insight is that such a source will not unconditionally share the story with both outlets to induce preemption concerns, formally outlined in Proposition 6 below.

Proposition 6. *When the source cares only about the quick release of stories,*

- *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, outlets in either situation are likelier to conduct research. By sending it to both outlets, she can also create a preemption risk. On the other hand, when intrinsic motivation is low, outlets are less likely to research. The source does not always want to share the story with both in this situation. 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, when v is high, the source is happy to share the story with both as preemption concerns will become salient for the outlets.[26]

6 | CONCLUSION

In the past decade, there have been increasing concerns about how the Internet has altered the incentives of media outlets, pushing them toward 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 showed 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 who do not. This result and intuition find support in some of the new media studies literature such as in Knobel (2018) and Carson (2019).

However, it is worth emphasizing the importance of a "sophisticated" audience that values accuracy and can observe the publication sequence. In this environment, the Bayesian structure of reputation building allows for more information to be transmitted, thus potentially countervailing the preemption effect of more competition. Regarding the first kind of sophistication, Gentzkow and Shapiro (2008) suggests that the 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 considering 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 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 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 deteriorate because of more time pressure.

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DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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ENDNOTES

[1] Such pressures toward speed-driven journalism are a cause of concern for modern democracies. Through fact-checking and investigative journalism, media outlets deliver revelations that profoundly impact 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 led 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.

[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*.

[3] See Section 3.3.2 of BBC editorial guidelines on: https://www.bbc.com/editorialguidelines/guidelines/accuracy/guidelines.

[4] The quote is from Lionel Barber's lecture on "Fake news in the post-factual age" at the Oxford Alumni Festival; Oxford University, September 16, 2017: https://www.ft.com/content/c8c749e0-996d-11e7-b83c-9588e51488a0.

[5] See the full table of her results in the online appendix I in Supporting Information S1. Link to the data on broadband coverage: https://ourworldindata.org/grapher/broadband-penetration-by-country?country=USA.

[6] In their model, when the audience does not choose to wait endogenously, increasing the number of firms has a negative effect on "fact-checking", except for the change from 1 to 2. In this case, the effect is positive because the monopolist has no incentives to fact-check due to the assumption that it would get the whole market. In our model, reputation is endogenously derived in equilibrium, so we do not have the same discontinuity in incentives between monopoly and duopoly: increasing the number of firms affects preemption risk and the information available for reputation building. Endogenous waiting decision by the audience can produce, in their model, a non-monotonic relationship between number of firms and fact-checking, but the trade-off is not related with reputation building.

[7] Hiller et al. (2015) studies empirically the welfare loss caused by a reduction in media competition that decreases diversity and advertising.

[8] Some recent papers that do not look at pricing explicitly but explore the political consequences of new media or of media competition are Sobbrio (2014), Cagé (2019), Allcott and Gentzkow (2017), Barrera et al. (2017), Chen and Suen (2016), Perego and Yuksel (2018) and Vaccari (2018). In all these papers, there is no speed-accuracy tradeoff.

[9] Our modeling strategy shares some features with Hafer et al. (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), Strömberg (2015) for recent developments in the political economy of media literature and other related papers.

[10] 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 the online appendix G.

[11] 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."

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[12] 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.

[13] This means we ignore equilibria where outlets endorse one particular state to signal their type. Alternatively, we can assume that signals are hard information; thus, outlets can only publish messages equal to their signal realization. The result would be the same. Moreover, given the flat prior beliefs on the state of the world, we ignore equilibria where high-type outlets may choose different research probabilities depending on the signal they receive.

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

[15] When the realized cost equals the threshold, we assume that indifference is resolved in favor of research.

[16] We show in the online appendix C in Supporting Information S1 that it is necessary that there be a positive probability that the competitor also possesses the first signal, or the scoop, to get our main result.

[17] In online appendix D in Supporting Information S1, we show that for a sufficiently high v and relevant off-path beliefs, the outlets never choose to wait. In appendix E in Supporting Information S1, we show that our main result is preserved even when the audience does not learn the state with a positive probability. Finally, in appendix F in Supporting Information S1, we show that our main result is preserved even in the extreme case where the second signal's precision after research is arbitrarily close to the first one.

[18] 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.

[19] Note that the cost is independently drawn. Therefore, this event happens with probability $0.5\sigma^i 0.5\sigma^j$ because each of them needs to draw a cost lower than the individual research threshold.

[20] In events $\{(R_\varnothing, W_\varnothing), (W_\varnothing, W_\varnothing)\}$ the same inference applies to outlet j as well.

[21] When $v > 1 + 2\varepsilon$, $c_D < -\varepsilon$ and $\sigma^* = 0$ is the unique equilibrium with $F(c_D(\sigma = 0)) = 0$.

[22] In Drago et al. (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 and 2010. While not direct evidence of our results, more information that the voters get with more outlets can drive the result in their paper.

[23] Note that these restrictions on k and π constitute sufficient conditions to ensure that in any equilibrium the patient audience prefer to remain undecided when the outlets publish together. Generally, for any $0 < k \leq 1$ or any $k > 1$ and $\pi \geq \frac{k}{k+1} > \frac{1}{2}$ and any equilibrium $\sigma > 0$, the patient audience consumes the content of any one (random) outlet when both publish together. However, for any $k > 1$ and equilibrium $\sigma > 0$,

- if $1 < k \leq 1 + \frac{2\sigma^2}{(2-\sigma)^2}$, the patient audience consumes the content of any one random outlet when both publish together,
- if $k > 1 + \frac{2\sigma^2}{(2-\sigma)^2}$ and $\frac{1}{2} < \pi < \frac{1}{k+1}\left(k - \frac{\sigma^2}{(2-\sigma)^2}\right)$, the patient audience remains undecided when both outlets publish together, and
- if $k > 1 + \frac{2\sigma^2}{(2-\sigma)^2}$ and $\pi \geq \frac{1}{k+1}\left(k - \frac{\sigma^2}{(2-\sigma)^2}\right) > \frac{1}{2}$, the patient audience consumes the content of any one random outlet when both publish together.

To maintain parallels with the model in Section 2 and for expositional ease, we restrict attention to the sufficient conditions above that induce the patient audience to avoid consuming content when both outlets move together.

[24] The outlet not receiving the signal will, therefore, publish something else, unrelated to the story.

[25] In equilibria where all outlets receiving the story publish it (in either period), an outlet that does not receive the story sees its reputation unchanged. Given the ex-post verification of the audience, it is possible to verify whether an outlet received the story or not, and staying silent when a signal is received is always off-path. Therefore, we can assume beliefs sufficiently low so that an equilibrium resembling the one in the benchmark model exists. Under this off-path restriction, we show that the change in the probability of matching the state from π^2 to π does not induce qualitatively different results on the role of competition and research. See online appendix B in Supporting Information S1 for further details. We also consider more general source preferences there.

[26] 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.

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APPENDIX A

Appendix with proofs of results in the main text

Proof of Proposition 1

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

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

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

$$\sigma^* = F(c_M(\sigma^*)) = \frac{c_M(\sigma^*) + \varepsilon}{\bar{c} + \varepsilon}. \tag{A1}$$

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$(\sigma^* = 1) = F\left(\frac{1-\pi}{1+\pi}\right)$. Therefore, the above is true.

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

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

but the sign of

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

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

$$-\pi(1-\pi)^2(2-\sigma^*)^3 + (\sigma^*+(1-\sigma^*)\pi+\pi)^3 > 0 \tag{A2}$$

It is easy to see that the LHS of Equation (A2) is strictly increasing in σ^* for all $\pi \in (0.5, 1)$. Moreover, the LHS of Equation (A2) when we substitute $\sigma^* = 0$ is $-1 + 2\pi > 0$. Consequently, the RHS of Equation (A1) is strictly increasing and convex. Combined with the above, there is only one fixed point in the [0,1] interval. ■

Proof of Proposition 2

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 (A3) defines the threshold c_D^i for outlet i.

$$c^i \leq \frac{1}{2}\left[\left(\gamma^i(\varnothing)-\gamma^i(1)\right)\left(\sigma^j-\left(2-\sigma^j\right)\pi^2\right)+\left(2-\sigma^j\right)\left(1-\gamma^i(1)\right)\right]-\frac{1}{2}\nu := c_D^i \tag{A3}$$

where $\gamma(\varnothing) = \frac{\sigma^i\sigma^j+\left(1-\sigma^i\right)\left(2-\sigma^j\right)\pi^2}{\sigma^i\sigma^j+(2-\sigma^i)(2-\sigma^j)\pi^2}$ 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 $[-\varepsilon, \overline{c}]$ 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

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

where

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

and

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

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

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 $f\left(c_D^i\right)\frac{\partial c_D^i}{\partial \sigma^i}$. 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 $\frac{\partial c_D^i}{\partial \sigma^i} = \frac{1}{2}\left[\frac{\left(\sigma^j - (2-\sigma^j)\pi^2\right)^2\pi^2\left(2-\sigma^j\right)}{\left(\sigma^i\sigma^j + (2-\sigma^i)(2-\sigma^j)\pi^2\right)^2} + \frac{2-\pi^2\left(2-\sigma^j\right)}{\left(2-\sigma^i\right)^2}\right]$ 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, $\frac{\partial c_D^i}{\partial \sigma^i}\big|_{\sigma^i=1} > \frac{\partial c_D^i}{\partial \sigma^i}\big|_{\sigma^i=0}$, and c_D^i reaches its steepest point around $\sigma^i = 1$. Therefore, it is enough to show that $\frac{\partial c_D^i}{\partial \sigma^i}\big|_{\sigma^i=1} \leq 1$. This requires

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

which further simplifies to

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

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

$$\hat{\sigma}^i\left(\hat{\sigma}^j\left(\sigma^i\right)\right) = \sigma^i \tag{A4}$$

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 Equation (A4) 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 $\sigma^i - F\left(c_D^i(\sigma^i, \sigma^j)\right) = 0$. (Going forward we drop the ˆ notation with an understanding that we are concerned with optimal responses.) As $\frac{\partial c_D^i}{\partial \sigma^i}\big|_{\sigma^i=1} \leq 1$, we can use implicit function theorem. Therefore,

$$\frac{\partial \sigma^i}{\partial \sigma^j} = \frac{\frac{\partial F\left(c_D^i\right)}{\partial \sigma^j}}{1 - \frac{\partial F\left(c_D^i\right)}{\partial \sigma^i}} \tag{A5}$$

Consider first the denominator of Equation (A5). From Step 2, we know that it is always positive. Moreover, it will be smaller the bigger is $\frac{\partial F\left(c_D^i\right)}{\partial \sigma^i}$. On the other hand, it is the biggest when $\frac{\partial F\left(c_D^i\right)}{\partial \sigma^i}$ is zero. When $\frac{\partial F\left(c_D^i\right)}{\partial \sigma^i}$ 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.

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

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

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

$$\frac{\partial c_D^i}{\partial \sigma^j}=\frac{1}{2}\left[\frac{\partial \gamma^i(\varnothing)}{\partial \sigma^j}\left(\sigma^j-\left(2-\sigma^j\right)\pi^2\right)+\gamma^i(\varnothing)+\pi^2\left(\gamma^i(\varnothing)-\gamma^i(1)\right)-1\right]. \tag{A6}$$

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

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

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

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

whose sign is ambiguous. However,

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

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,

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

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

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

$$\frac{\partial}{\partial \sigma^i}\left(\frac{\partial \gamma^i(\varnothing)}{\partial \sigma^j}|_{\sigma^j=1}\right)=\frac{\partial}{\partial \sigma^i}\left(\frac{2\sigma^i\pi^2}{\left(\sigma^i+(2-\sigma^i)\pi^2\right)^2}\right)=\frac{2\pi^2\left(\sigma^i+(2-\sigma^i)\pi^2\right)-4(1-\pi^2)\sigma^i\pi^2}{\left(\sigma^i+(2-\sigma^i)\pi^2\right)^3} \tag{A7}$$

Note that the relevant expression in (A7) 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 maximized at $\sigma^i = 1$, and

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

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 $\arg\max_{\sigma^i} \frac{\partial \gamma^i(\varnothing)}{\partial \sigma^j}|_{\sigma^j=1} = \frac{2\pi^2}{1-\pi^2} \in [0,1]$. 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 $\pi^2 \leq \frac{2}{3}$, that is, 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 Equation (A5) can be found by making the relevant replacement from above to Equation (A6). Therefore,

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

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 Equation (A6), note that

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

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 maximized 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

$$\sigma^i = \sigma^j = \sigma^* = F(c_D(\sigma^*)) \tag{A8}$$

where from Equation (A3)

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

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Looking at Equation (A8), note that both LHS and RHS are continuous on the [0, 1] interval. Moreover, $\text{RHS}(\sigma^* = 0) \geq 0 = \text{LHS}(\sigma^*)$ and $\text{RHS}(\sigma^* = 1) < 1 = \text{LHS}(\sigma^* = 1)$. 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 $\pi\gamma^i(1) + (1 - \pi)[\pi\gamma^i(\varnothing) + (1 - \pi)\gamma^i(1)]$. Again, the former is strictly bigger than the latter because $\gamma^i(\varnothing) \geq \gamma^i(1)$. ■

Proof of Lemma 1

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

$$\frac{1}{2}\left[(\gamma(\varnothing) - \gamma(1))\left(\sigma - (2-\sigma)\pi^2\right) + 1\right] > (1-\pi)(\gamma(R) - \gamma(W)) \tag{A9}$$

Observe that $\gamma(1) = \gamma(W) = \frac{1-\sigma}{2-\sigma}$. Moreover, define $\gamma(\varnothing) - \gamma(1) := A$. Rearranging Equation (A9) we get

$$\frac{1}{2}[A\sigma + 1] > (1-\pi)(\gamma(R) - \gamma(W)) + \frac{1}{2}A(2-\sigma)\pi^2 \tag{A10}$$

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,

$$\frac{\partial A}{\partial \sigma} = \frac{2\sigma(2-\sigma)(\sigma^2 + (2-\sigma)^2\pi^2) - \sigma^2(\sigma^2 + 3(2-\sigma)^2\pi^2 - 2\sigma(2-\sigma))}{((2-\sigma)(\sigma^2 + (2-\sigma)^2\pi^2))^2} \tag{A11}$$

Signing Equation (A11) is not easy in its current form. However, it is clear that $\lim_{\sigma\to 0}\frac{\partial A}{\partial \sigma} = 0$. Moreover, when $\sigma \neq 0$, we can rearrange A in a more tractable way. In particular, $A = \frac{1}{(2-\sigma)\left(1+\pi^2B^2\right)}$ 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

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

Defining the sign of $\frac{\partial^2 A}{\partial \sigma^2}$ is more complicated, but as A is defined over just two parameters, $\sigma \in [0,1]$ and $\pi \in (0.5, 1)$, we can prove graphically that $\frac{\partial^2 A}{\partial \sigma^2} > 0$. In particular, Figure A1 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 (A10) $\frac{\partial \text{LHS}}{\partial \sigma} > 0$ and $\frac{\partial^2 \text{LHS}}{\partial \sigma^2} > 0$ so the LHS is strictly increasing and convex. Moreover, $\frac{\partial \text{RHS}}{\partial \sigma} > 0$.

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

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

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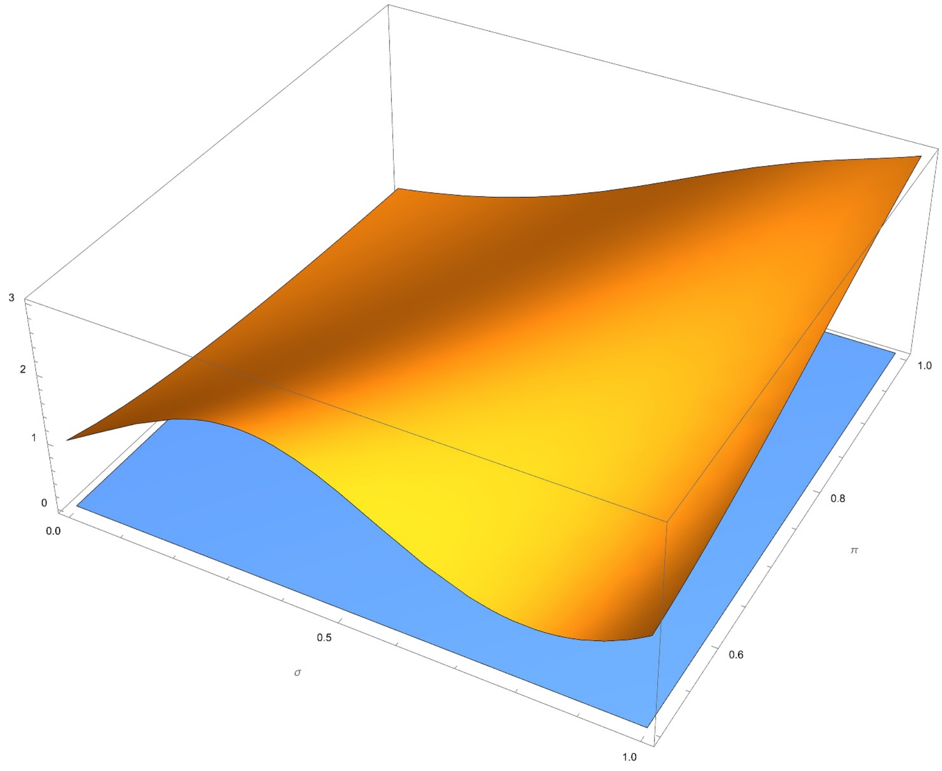

FIGURE A1 Proof of Lemma 1: Proving $\frac{\partial^2 A}{\partial \sigma^2} > 0$. Orange plane: $\frac{\partial^2 A}{\partial \sigma^2}$, blue plane: $0.\sigma + 0.\pi$ in $\pi - \sigma$ space.

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 3

Proof. This follows directly from the strict inequality of Equation (A9) and the fact that v only reduces its LHS without affecting the RHS. ■

Proof of Corollary 1

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

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

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

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Therefore, the cost threshold for research is given by

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

which simplifies to

$$c\leq(1-\pi)\left(\gamma^i(R)-\gamma^i(W)\right)-\frac{1}{2}v:=c'_D \tag{A12}$$

Note that the first part of Equation (A12) 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, that is,

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

where $c'_D = c_M - \frac{1}{2}v$. The same logic of the proof of Proposition 1 also applies here. 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

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

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

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

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 $\bar{c}>1$. ■

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Proof of Proposition 4

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 $\bar{c}_D \leq c_M$. This requires

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

Notice that LHS = RHS at $\sigma = 0$. When $\sigma > 0$, we use the terminology introduced in Lemma 1 and rewrite the above as

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

The LHS and the RHS of the above equation are only functions of two variables, π and σ. Therefore, we can plot them in a graph (see Figure A2) with $\pi \in [0, 1]$ and $\sigma \in [0, 1]$ 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

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

We showed in Lemma 1 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, $\bar{c}_D(u = 0) > c_D(v = 0) > c_M$.

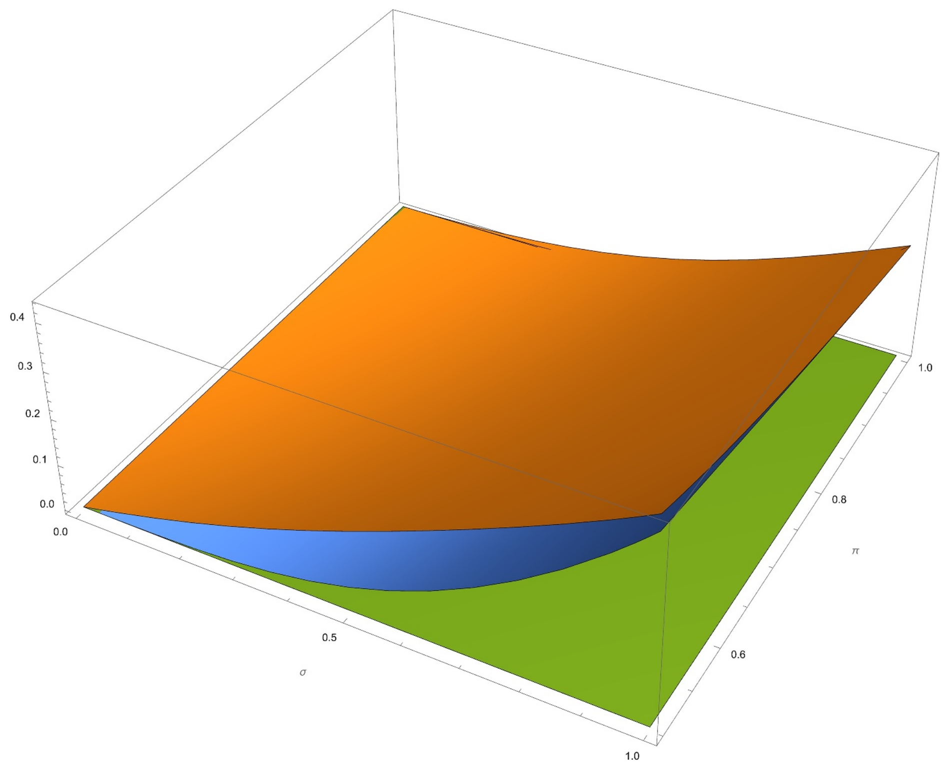

FIGURE A2 Proof of Proposition 4: Proving LHS < RHS. Orange plane: RHS, blue plane: LHS, and green plane: $0.\sigma + 0.\pi$ in the $\pi - \sigma$ space.

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Combining the three parts above, our result follows. ■

Proof of Proposition 5

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).

$$\begin{aligned}\frac{\partial V}{\partial \pi} &= u\frac{(4-\sigma^2)}{4} + \left[\frac{\pi u}{2}(\sigma-4) + \frac{(1-u)}{2}2(1-\sigma) + \frac{(u)}{2}\sigma\right]\frac{\partial \sigma}{\partial \pi} \\ &= u\frac{(4-\sigma^2)}{4} + \frac{2(1-\sigma) - u[(2+4\pi) - \sigma(\pi+3)]}{2}\frac{\partial \sigma}{\partial \pi}\end{aligned} \tag{A13}$$

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

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

Further, using the definitions in the proof of Lemma 1, we can rewrite K as

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

Differentiating and simplifying, we first obtain

$$\begin{aligned}\frac{\partial K}{\partial \pi} := K_\pi &= -\frac{1}{2(\overline{c}+\varepsilon)}\left[\frac{-2\pi B^2(\sigma - (2-\sigma)\pi^2)}{(2-\sigma)\left(1+\pi^2 B^2\right)^2} - \frac{2\pi}{1+\pi^2 B^2}\right] \\ &= \frac{1}{2(\overline{c}+\varepsilon)}\frac{2\pi(1+B)}{\left(1+\pi^2 B^2\right)^2} > 0,\end{aligned} \tag{A14}$$

and second, we obtain

$$\begin{aligned}\frac{\partial K}{\partial \sigma} := K_\sigma &= 1 - \frac{1}{2(\overline{c}+\varepsilon)}\left[\frac{\partial A}{\partial \sigma}\left(\sigma - (2-\sigma)\pi^2\right) + \left(1+\pi^2\right)A - (1-u)\right] \\ &= 1 + \frac{1}{2(\overline{c}+\varepsilon)}(1-u) - \frac{1}{2(\overline{c}+\varepsilon)}\left[\frac{\partial A}{\partial \sigma}\left(\sigma - (2-\sigma)\pi^2\right) + \left(1+\pi^2\right)A\right] \\ &= 1 + \frac{1}{2(\overline{c}+\varepsilon)}(1-u) - \frac{1}{\overline{c}+\varepsilon}\frac{\partial c_D}{\partial \sigma}\end{aligned} \tag{A15}$$

where c_D is the cost threshold we derived in Proposition 2.

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 G2 (see online appendix G in Supporting Information S1) 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 Equation (A13), this happens when

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

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, note 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 $\frac{\pi(-4+\sigma)+\sigma}{2} < 0$ owing to the fact that $\pi > \frac{1}{2}$. Since the RHS is a continuous function of u, it must cross the LHS at least once. Therefore, $\overline{u}^V$ exists and lies between 0 and 1. ■

Proof of Proposition 6

Proof. The proof is by construction. Begin with Lemma B1 (see online appendix B in Supporting Information S1), where we construct the equilibrium frontier and the set of all possible equilibria for a given $\overline{c}$ and ε.

We now show what happens as $\varepsilon \to 0$. Consider σ_M first. From Proposition 1, observe that as $\varepsilon \to 0$ LHS$(\sigma = 0) = 0 \approx$ RHS$(\sigma = 0) = \frac{\varepsilon}{\overline{c}+\varepsilon} \to 0$ in Equation (A1). Therefore, for any π, the only fixed point equilibrium $\to 0$.

Now, consider σ_D at $\nu = 0$. Fix a π. We know that as $\varepsilon \to 0$, since $c_D(\sigma = 0) = \frac{1}{2}$, we have that RHS$(\sigma = 0) \to \frac{1}{2\overline{c}}$ in Equation (A8). 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 $\sigma^* = \frac{c^*+\varepsilon}{\overline{c}+\varepsilon}$, both σ_M and σ_D approach 1 (without ever being exactly equal to 1). However, because the frontier is defined for $\nu = 0$ case, the frontier lies close to and to the right of the $\sigma_M = \sigma_D$ line.

Combining the two observations above with Lemma B1, we get our proposition. ■

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