Media Competition and Social Disagreement

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Abstract

We study the competitive provision and endogenous acquisition of political information. Our main result identifies a natural equilibrium channel through which a more competitive market decreases the efficiency of policy outcomes. A critical insight we put forward is that competition among information providers leads to informational specialization: Firms provide relatively less information on issues that are of common interest and relatively more information on issues along which agents' preferences are heterogeneous. This enables agents to acquire information about different aspects of the policy, those that are particularly important to them. This leads to an increase in social disagreement, which has negative welfare implications. We establish that, in large enough societies, competition makes every agent worse off by decreasing the utility that she derives from the policy outcome. Furthermore, we show that this decline cannot be compensated by the decrease in prices resulting from competition.

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1. Introduction

We study the competitive provision and endogenous acquisition of political information. Our interest is motivated by a growing public debate on the consequences of a fast-changing media landscape and information consumption habits on our democracies.[1] The political economy literature still lacks a comprehensive understanding of how competition affects the strategic incentives of information providers in this market and its possible consequences on the political process. We contribute to filling this gap, by presenting a simple model in which nonpartisan information providers compete for agents who acquire information before they cast a vote. Our analysis leads to three novel conclusions: First, we show that competition leads to informational specialization. The critical insight we put forward is that competition forces information providers to become relatively less informative on issues that are of common interest, and hence are particularly important from a social perspective. Second, we analyze the downstream effects of such specialization and show that, while agents become better informed on an individual level, competition amplifies social disagreement. Third, we highlight the social welfare implications of increased disagreement. Specifically, we establish that, in societies that are large enough, competition makes every agent worse off by decreasing the utility that she derives from the policy outcome.

In our model, a finite number of firms compete to provide information to a finite number of Bayesian agents about a newly proposed policy with uncertain prospects. Whether the new policy is implemented to replace a known status quo depends on its approval rate. The policy features a vertical component, a *valence* aspect, on which preferences are identical, and two horizontal components, *ideological* aspects, on which preferences are heterogeneous. Each firm sells a signal about the policy but faces a constraint on how informative such a signal can be on the different components. That is, being more precise about one of these three components requires the firm to be less precise about the other two. To fix ideas, imagine a new health care bill is under discussion, the details of which are not yet fully known by the public. The bill potentially affects many dimensions of social life, and voters might evaluate these dimensions differently. For example, the new bill could promote an increase in the overall quality of health care (vertical dimension), expand the budget deficit (horizontal), and induce more redistribution via increasing the share of the population covered (horizontal). Voters acquire information from the media before they approve or disapprove the policy. A larger

[1] Pew Research Center (2016), Sunstein (2017), and Nichols (2017) provide a comprehensive description of the media market and how it dramatically changed in the last years.

consensus increases the probability that the bill is ultimately implemented. Media compete for profits by allocating their limited resources (journalists, airtime, etc.) to a possibly different mix of these policy components and by setting prices.

The equilibrium of our model demonstrates how competition among information providers induces informational specialization. While all agents want to learn about the policy, different agents care about different aspects of it. To maximize profits, firms sell information that is valuable for a diverse set of agents. They can do so by being informative about aspects of the policy that are of common interest, i.e., valence. However, as the market becomes more competitive, the effectiveness of such a generalist approach declines; different firms target different agents, providing signals tailored to those specific agents' informational needs. This kind of specialization does not seem special to our setup, but rather appears to be a generic feature of the competitive provision of information by profit-maximizing firms to a heterogeneous audience.

The equilibrium analysis leads to novel insights. We find that competition creates a broader spectrum of informational options, enabling agents to acquire information that is better aligned with their needs. Also, the market does not overspecialize. Indeed, as the number of competing firms grows large, the equilibrium converges to a *daily-me* paradigm, a situation in which each agent finds an information provider that perfectly meets her unique informational needs (Sunstein, 2001). Furthermore, competition decreases the price associated with such information. Thus, competition benefits agents by enabling them to be better informed at lower prices. These results conform to the classic view that sees the market for news as a "marketplace of ideas," promoting knowledge and the discovery of truth.[2] More generally, it aligns with previous results in this literature that we will review below.

We then use our model as a benchmark to study the effects of competition on welfare, which extend well beyond the individual information acquisition stage. The market for political news differs from other markets partly because it has an indirect effect on welfare through information externalities imposed on the political process. Such a process, by definition, aggregates the opinions of agents who are potentially in conflict with each other. We show that such aggregation implies that the information provided by the market has a *direct* and an *indirect* value for any agent. The *direct* value measures how the information that an agent personally acquires enables her to sway the policy outcome in the direction of her own preferences. The *indirect* value, instead, measures how the information acquired by others is used to sway the policy outcome towards their preferences. Agents, trying to maximize their own impact on the political process, acquire information based on its *direct* value. Consequently, a competitive mar-

[2] See Posner (1986) for a wide-ranging introduction to this classic view.

ket specializes to meet such demand. However, as firms specialize, agents learn about increasingly different aspects of the policy. Thus, their opinions diverge leading to an increase in social disagreement. This generates a decline in the *indirect* value of information, capturing the externality agents impose on others. Our main result demonstrates that, in large enough societies, this externality becomes critical. That is, the utility that each agent derives from the policy outcome decreases with competition. Moreover, this decline cannot be compensated by the decrease in prices resulting from competition.

Finally, we discuss how the main insights of the paper extend beyond our simplifying assumptions by comparing two extreme market structures: monopoly and perfect competition. This highlights further the importance of two key features of our model: the heterogeneity in agents' preferences and the constraints on how much agents can learn about the policy. The interaction of these features leads to information specialization, which plays a critical role in the inefficiency identified in this paper.

The rest of the paper is organized as follows. The next subsection reviews the related literature and discusses the empirical implications of our work. Section 2 introduces the model, while Section 3 characterizes its equilibrium. Our main results are presented in Section 4 and Section 5 discusses their extensions. All proofs are relegated to the Appendix.

1.1. Related Literature and Empirical Implications

Our paper contributes to the burgeoning literature on the political economy of mass media.[3] Specifically, we contribute to the branch of this literature that studies the effects of the endogenous provision of information and its externalities on the political process. One robust finding of this literature is that when information providers are partisans – namely, they are interested in persuading the public to take a certain action – competition generally brings about better social outcomes. Intuitively, competition forces firms to better align with what consumers demand, thus reducing their inherent biases. Results along this line are reflected in the works of Baron (2006), Chan and Suen (2009), and Anderson and McLaren (2012).[4] Similarly, Duggan and Martinelli (2011) find that slanting is an equilibrium outcome in a richer model that allows for electoral competition, but otherwise abstracts away the problem of competitive infor-

[3]See Prat and Strömberg (2013) and Gentzkow et al. (2015) for recent and comprehensive reviews of the literature.

[4]The welfare-increasing effects of competition are also illustrated in Besley and Prat (2006), Corneo (2006) and Gehlbach and Sonin (2014), although for orthogonal reasons from those discussed here, namely the potential risks of media capture by the government.

mation provision. While not modeling competition, the works of Alonso and Câmara (2016) and Bandyopadhyay et al. (2020) also belong to this strand of the literature. Instead, a general treatment of competition among biased senders is discussed in Gentzkow and Kamenica (2016). Our work differs from these papers as we assume that information providers are nonpartisans and compete for profits. Chan and Suen (2008) consider a model with features that can be mapped back to our setup. Their primary interest, however, is to study the effects of exogenously located firms on electoral competition. They show that a new entrant increases the probability that parties will choose the policy favored by the median voter, thereby increasing social welfare. In an extension, they also endogenize competition, but the only industry structure they can feasibly analyze (a duopoly) typically leads to higher welfare. Closer to our work, Chen and Suen (2018) study a competition model in which biased media firms compete for the scarce attention of readers, finding that an increase in competition leads to an increase in the overall informativeness of the industry. Similarly, results consistent with the idea that competition is welfare-increasing are discussed in Burke (2008), Gentzkow and Shapiro (2006), and Gentzkow et al. (2014). Sobbrio (2014) does not analyze the social welfare implications of media competition, but shows that competition can lead to specialization. Galperti and Trevino (2020) study a model of endogenous provision and acquisition of information and show how competition for attention can lead to a homogeneous supply of information, even when consumers would value accessing heterogeneous sources. Overall, when consumers are rational, the evidence is stacked in favor of the welfare-increasing effects of media competition. Our paper contributes to this literature by developing a full-fledged competition model that illustrates a novel and natural channel through which competition can be welfare-decreasing. While not analyzing the competitive provision of information, Ali et al. (2018) study the interaction between private information and distributive conflicts in the context of a voting game. More specifically, they provide necessary and sufficient conditions under which the strategic interactions among agents can preclude a policy that is both ex-ante and ex-post optimal from being implemented. This is due to a form of adverse selection when information is scarce, an effect that is markedly distinct from the inefficiency we highlight in this paper. Departing from the assumption of rationality when processing information, Mullainathan and Shleifer (2005) consider a model in which heterogeneous consumers derive psychological utility from their prior views being confirmed by new observations. Consistent with the findings discussed above, they also find that more competition leads to specialization and a decrease in prices. In a related model with agents having behavioral preferences for confirmation, Bernhardt et al. (2008) study the welfare implications of competition, showing that competition increases the probability the society will make mistakes in policy selection. Bordalo et al. (2016) analyze a model in which two firms compete for the attention of a group of "salient thinkers" by strategically setting the quality and the price of the product they sell. They show how distortions in consumers' perception can explain the equilibrium degree of commoditization of some markets. Relatedly, Matějka and Tabellini (2019) study policy selection when voters are rationally inattentive. Complementing our results, they find that divisive issues attract the most attention by voters and that this can create inefficiencies in public good provision.

Empirical Implications. Our paper also relates to the large empirical literature that specifically studies the effects of media competition on political participation and electoral outcomes (Stromberg (2004), Gentzkow (2006), Stone and Simas (2010), Gentzkow et al. (2011), Falck et al. (2014), Drago et al. (2014), Miner (2015), Cagé (2020), Gavazza et al. (2019), Campante et al. (Forthcoming)).[5] Our paper contributes to this literature with three distinct empirical predictions. First, it predicts that stronger media competition leads to more informational specialization. To date, a great deal of attention in the empirical literature was dedicated to media ideological biases. Our paper shows that, even in the absence of such biases, firms can specialize their products by creating content that, while not ideologically slanted, targets audiences with different preferences. The analysis of news' content involves non-trivial technical challenges. However, novel empirical methods that exploit machine learning techniques to analyze textual data have provided initial evidence that aligns with content specialization, as formalized by our model. Angelucci et al. (2020) explore the content production of local newspapers in the 50ies, as they started competing with television. They find evidence of content specialization, taking the form of an increased emphasis on local news, as opposed to national ones. Similarly, Nimark and Pitschner (2019) provide a comprehensive and recent account of the extent to which American newspapers specialize in the production of their content. Finally, Martin and Yurukoglu (2017) find evidence of content specialization for major cable outlets and provide evidence of correlation with competition. While more research on this topic is needed, the use of these novel techniques is expected to grow in the field (Gentzkow et al. (2019)). Second, our model predicts that an increase in media competition is correlated with an increase in disagreement even among rational agents. There is a growing literature analyzing polarization in public opinion. Several papers have investigated this channel (e.g., Prior (2013), Campante and Hojman (2013)), but the evidence is mixed and more research is needed. Finally, our model predicts that content specialization will develop at the expense of information about valence issues, dimensions of the policy space along which agents have particularly homogeneous preferences.

[5]While not explicitly focusing on media competition, DellaVigna and Kaplan (2007) and, more recently, Martin and Yurukoglu (2017) study the effect of biased news on voting behavior. Relatedly, Boxell et al. (2017) study the relationship between social media use and polarization.

2. Model

This section introduces the model and discusses its main assumptions. We model the interaction among a group of firms and agents: Firms choose what information to produce about an uncertain policy and its price for each agent; agents choose which firm to acquire information from and whether to approve or disapprove the policy, thereby affecting its chances of being implemented.

We now formally introduce the components of the model. There are $N \geq 1$ identical firms and $I \geq 1$ heterogeneous and Bayesian agents. We denote a typical firm by n, a typical agent by i, and her payoff-type by θ_i. Firms and agents interact over three consecutive stages as depicted in Figure 1.

In the first stage, before learning the agents' types, firms compete to provide information to the agents about an uncertain policy $\omega = (\omega_0, \omega_1, \omega_2)$, whose components are identically distributed as independent standard normals. Specifically, each firm n chooses an *editorial strategy* $b_n = (b_{n,0}, b_{n,1}, b_{n,2})$, subject to the constraint that $||b_n|| \leq 1$.

In the second stage, agents' types $(\theta_1, \ldots, \theta_I)$ realize publicly. Each firm n observes the other editorial strategies and chooses a price $p_n(\theta_i)$ for each agent.

In the last stage, agents observe the editorial strategies of the firms and their respective prices. Each agent chooses one firm from which to acquire information. If agent i chooses firm n, she pays the price $p_n(\theta_i)$ and privately observes a signal realization $s_i(\omega, b_n) = b_n \cdot \omega + \varepsilon_i$. The error term ε_i is independent across firms and agents and is distributed as a standard normal. Finally, conditional on the observed signal, the agent approves or disapproves the policy. The policy is implemented with a probability equal to its approval rate, which is the fraction of agents who approved the policy. If the policy is implemented, agent i earns a payoff $u(\omega, \theta_i)$. Otherwise, the status quo prevails, whose utility is normalized to zero.

Payoffs. The agent's payoff $u(\omega, \theta_i)$ is meant to capture the impact of a policy ω with both "vertical" and "horizontal" components. To this purpose, we assume that the agent's type is $\theta_i = (1, \theta_{i,1}, \theta_{i,2})$ and let $u(\omega, \theta_i) = \theta_i \cdot \omega$. That is, agents have identical preferences over ω_0—the "vertical" component of the policy. By contrast, agents have heterogeneous preferences on the remaining components, ω_1 and ω_2. We conveniently normalize $\theta_{i,1}^2 + \theta_{i,2}^2 = 1$ and assume that the agent's type θ_i is independently drawn from the uniform distribution F, subject to this constraint.

Firms maximize expected profits, which depend on the agents' types, the information they

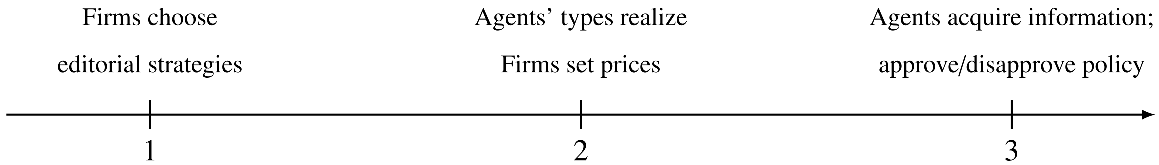

FIGURE 1: Timeline

acquire, and the price they pay. Agents maximize their expected utility, which depends on the implemented policy (if any) and the price paid for information. The solution concept is Perfect Bayesian Equilibrium, which we characterize in the next section.

2.1. Discussion

We pause for a brief discussion of our main assumptions. The model has two key features: heterogeneity in agents' preferences and constraints on firms' supply. Under these conditions, competition is known to lead to product differentiation (Tirole, 1988). In this sense, informational specialization in our model is driven by well-known forces. Absent the former feature, all agents would demand the same information. Absent the latter, all firms would supply the same information—a fully revealing signal. While there are several different ways in which such features could be introduced, our modeling choices provide tractability and allow for a transparent depiction of the main forces behind our results.

On the agents' side, we introduce heterogeneity by assuming that θ_i is uniformly distributed on the *two* ideological components.[6] The symmetry of this setup is just a modeling tool that allows us to characterize the equilibrium of the game for an arbitrary number of firms. Moreover, it enables us to think of information provision as a location problem on a disk, in the spirit of Salop (1979). In Section 5.1, we relax the uniformity assumption and allow for a large class of type distributions. On the firms' side, instead, we assume that firms are constrained in the resources—journalists, pages, airtime, etc.—they can allocate on the components of the policy. Each component of the editorial strategy b_n represents the firm's emphasis on the corresponding component of the policy. More emphasis translates into a signal that is more informative about such component. This substitutability generates the trade-off that is at the heart

[6]Pew Research Center (January, 2017) provides evidence on the differences in voters' agendas. Consistently, multidimensional preferences with similar characteristics are common in this literature. See for example Groseclose (2001), Eyster and Kittsteiner (2007), Carillo and Castanheira (2008), Ashworth and de Mesquita (2009), Dragu and Fan (2016), Aragones et al. (2015), and Yuksel (2020) for applications in the context of party competition, and Alesina et al. (1999), Lizzeri and Persico (2005), and Fernandez and Levy (2008) for applications to public goods.

of our model. In Section 5.2, we study a model of multimedia where agents can acquire information from multiple firms.

Two other assumptions in our model grant further discussion. First, the finite number of agents guarantees information to have an *instrumental* value in our model. Each agent acquires information because her approval decision directly affects the policy outcome. Second, we assume that the policy is implemented probabilistically, as a function of the approval rate. This eliminates the scope for learning about the policy by engaging in pivotal reasoning and reduces the complexity of the agents' problem, while enabling us to focus attention on the most novel aspect of the model—the competitive supply of information.

Finally, prices in our model do not necessarily need to represent monetary transfers from agents to firms. Alternatively, they can be interpreted as advertising revenues. In this interpretation, firms compete for the attention of each agent which increases with the value of the information produced by the firm but decreases with the intensity of advertisement the agent observes. Note that we assume perfect price discrimination by formally allowing prices to be type-specific. While forms of price discrimination are common in the market for news, such an assumption is arguably even more reasonable when prices are interpreted to be linked to advertisement, which nowadays is increasingly targeted.

3. Equilibrium

This section is devoted to the analysis of the equilibrium of our game. First, we establish equilibrium existence by solving the game via backward induction. Second, we illustrate how to transform the firm's problem into an equivalent location problem on a disk. This is not only analytically convenient but also provides a useful spatial interpretation of firms' equilibrium behavior. Building on this spatial interpretation, we conclude by discussing the uniqueness of the equilibrium.

3.1. Existence and Characterization

3.1.1. The Agent's Problem: Information Acquisition and Approval

We begin by characterizing equilibrium behavior in the last stage of the game. In this stage, agents choose which information to acquire and whether to approve the policy. Their equilibrium behavior is relatively straightforward. To begin, fix a type θ_i and suppose that she acquires information from firm n, whose editorial strategy is b_n. Conditional on observing the signal realization, this type's equilibrium approval strategy is independent of the other agents' strategies, as shown by the following result.

Lemma 1 (Approval)**.** *Conditional on a signal realization* $\bar{s}_i = s(\omega, b_n)$*, type* θ_i *approves the policy if and only if* $\mathbb{E}_\omega(u(\omega, \theta_i)|\bar{s}_i) \geq 0$.

The agent's decision to approve the policy materially affects the outcome of the game, since it changes the probability that the policy is ultimately implemented. Nonetheless, her equilibrium strategy is simple and abstracts from pivotal reasoning. Indeed, each agent behaves as if she was voting expressively (Brennan and Buchanan (1984)). Specifically, she computes the expectation of $u(\omega, \theta_i)$ conditional on $\bar{s}_i$ and approves the policy if and only if it leads to a payoff that is higher than the status quo. Lemma 1 follows from the fact that the policy is implemented probabilistically, as a function of the approval rate. Because of this, each agent impacts the policy outcome equally (with $1/I$ probability in our case) regardless of the decisions of others. This eliminates the scope for learning about the policy by engaging in pivotal reasoning.

Next, we characterize the information-acquisition strategies of the agents. Since approval decisions directly affect the policy outcome, agents attach instrumental value to the information they acquire. Let us define the (direct) *value of information* associated with editorial strategy b_n for agent i to be the difference between i's ex-ante utility (abstracting from prices) of observing a signal from firm n and the ex-ante utility of observing no signal whatsoever. Characterizing the value of information is a key step for characterizing the equilibrium of the game.

Lemma 2. *The* value of information $s_i(\omega, b_n)$ *for an agent of type* θ_i *is*

$$v(b_n|\theta_i) = \frac{|\theta_i \cdot b_n|}{I\sqrt{2\pi(1 + ||b_n||)}}.$$

Lemma 2 computes the value of information from firm n for type θ_i. It establishes that such value is independent of the information acquired by other agents and, hence, the editorial strategies of firms other than n. The value of information has several intuitive properties. First, it is decreasing in the number of agents I. This captures the fact that the larger a society, the smaller the marginal impact that an agent has on the policy outcome, thus decreasing the instrumental value that such an agent assigns to information. Second, the value of information is increasing in $|\theta_i \cdot b_n|$, which corresponds to the statistical correlation between the agent's utility $u(\omega, \theta_i)$ and the signal $s_i(\omega, b_n)$. We will return to this point shortly in Section 3.2.

A simple implication of Lemma 2 is that, in equilibrium, type θ_i chooses the firm that provides the highest value of information, net of the price. More formally, given a profile of editorial strategies and prices, $(b_n, p_n(\theta_i))_{n=1}^N$, type θ_i acquires information from firm n only if $v(b_n|\theta_i) - p_n(\theta_i) \geq v(b_m|\theta_i) - p_m(\theta_i)$, for all m.

3.1.2. The Firms' Problem: Prices and Editorial Strategies

We now turn to the analysis of firms' equilibrium behavior. We begin with the second stage of the game, where firms set prices after observing each other's editorial strategies $b = (b_n)_{n=1}^N$ and the agents' realized types $(\theta_1, \ldots, \theta_I)$. Each firm maximizes profits, which are affected by the prices it can charge to its readers. Firms set a price for each type θ_i and, hence, compete *à la* Bertrand for each potential reader.

To provide intuition on what prices prevail in equilibrium, let us consider a simple example where two firms compete for type θ_i. Suppose that their editorial strategies, b_1 and b_2, are such that $v(b_1|\theta_i) > v(b_2|\theta_i)$. Then, the most competitive price that firm 2 can set is $p_2(\theta_i) = 0$. Even in this case, firm 1 could nonetheless win the agent, by simply setting a price $p_1(\theta_i) < v(b_1|\theta_i) - v(b_2|\theta_i)$. Therefore, in equilibrium, firm 1 must win the agent with probability one and earns a profit equal to $p_1(\theta_i) = v(b_1|\theta_i) - v(b_2|\theta_i)$.

This reasoning easily generalizes to $N > 2$. Fix a profile of editorial strategies $b = (b_n)_{n=1}^N$. In equilibrium, firm n wins type θ_i only if $v(b_n|\theta_i) \geq \max_{m \neq n} v(b_m|\theta_i)$, in which case she earns a profit of $p_n(\theta_i) = v(b_n|\theta_i) - \max_{m \neq n} v(b_m|\theta_i) \geq 0$. Conversely, if $v(b_n|\theta_i) < \max_{m \neq n} v(b_m|\theta_i)$, the firm loses type θ_i and earns no profit. Conveniently, the equilibrium profit that firm n accrues from type θ_i is uniquely pinned down as $p_n(\theta_i) = \max_m v(b_m|\theta_i) - \max_{m \neq n} v(b_m|\theta_i) \geq 0$. Therefore, firm n's total profit is $\sum_{i=1}^I \max_m v(b_m|\theta_i) - \max_{m \neq n} v(b_m|\theta_i)$, which is uniquely pinned down as a function of the profile of editorial strategies b.

Finally, we analyze the first stage of the game. Firms choose their editorial strategies before observing the agents' types, which are identically and independently distributed according to F. That is, for any profile of editorial strategies (b_n, b_{-n}), firm n's expected profit is

$$\Pi_n(b_n, b_{-n}) = I\mathbb{E}_{\theta_i}\Big(\max_m v(b_m|\theta_i) - \max_{m \neq n} v(b_m|\theta_i)\Big). \tag{1}$$

In the first stage of the game, firms play a one-shot complete-information game with payoffs defined by Π_n. The next result establishes the existence of a pure-strategy Nash Equilibrium in the first stage of the game.

Theorem 1. *(Existence) A pure-strategy equilibrium $(b_n)_{n=1}^N$ exists.*

By construction, Π_n accounts for the equilibrium behavior of firms and agents in the subsequent stages of the game. By backward induction, a Nash Equilibrium of the first-stage game corresponds to a PBE in the grand game, and the equilibrium strategies for the subsequent stages, both on and off the equilibrium path, are defined as described above. Conversely, any PBE of the grand game must induce a Nash Equilibrium in the first-stage game.

3.2. Information Provision as a Location Problem

This subsection is devoted to the discussion of the equilibrium and its properties. For this purpose, we transform the firms' problem in the first stage of the game, which consists of choosing editorial strategies, into an equivalent location problem on a disk. This transformation is both conceptually and analytically convenient, as it facilitates the interpretation of the equilibrium and allows us to characterize its uniqueness. We do so by transforming the agent's type θ_i and the firm's editorial strategy b_n into polar coordinates.

Remark 1. *Let* $T = [-\pi, \pi]$.

- *For all* θ_i*, a unique* $t_i \in T$ *exists such that* $\theta_i = (1, \cos(t_i), \sin(t_i))$.
- *For all* b_n *such that* $||b_n|| = 1$*, a unique pair* $(x_n, t_n) \in [0, 1] \times T$ *exists such that* $b_n = (\sqrt{x_n}, \sqrt{1 - x_n}\cos(t_n), \sqrt{1 - x_n}\sin(t_n)))$.

In light of the equivalence of Remark 1, we abuse terminology and notation in the remainder of the paper and refer to t_i as the agent's type and to the pair (x_n, t_n) as the firm's editorial strategy.[7]

In this equivalent formulation of the model, each agent's type t_i is a *location* on the unit circle and it is drawn uniformly from the set T. The closer two types t_i and t_j are to each other, the higher the correlation between their preferences $u(\omega, t_i)$ and $u(\omega, t_j)$. In this sense, the arc distance between any two types on the circle represents their *ideological* distance.[8]

A firm's editorial strategy, instead, is equivalent to choosing the pair (x_n, t_n), with the following interpretation: x_n captures how *generalist* the firm is, as it measures the relative informativeness of the firm's signal about the valence vs. ideological components; t_n is the firm's *target* type, an agent who evaluates the different ideological components ω_1 and ω_2 of the policy in a way that perfectly matches the corresponding relative weights in the signal designed by

[7] Note that, in Remark 1, we focus on editorial strategies for which the constraint $||b_n|| \leq 1$ binds. Intuitively, these are the only strategies that firms use in any equilibrium. This point is formalized in Lemma A1, in Appendix A.

[8] A vast empirical literature measures polarization using the bliss-point distance as a proxy for ideological distance. Our model shows that two agents can be ideologically similar even when their respective "bliss points" are not. This happens when they trade off the components of the policy in similar ways.

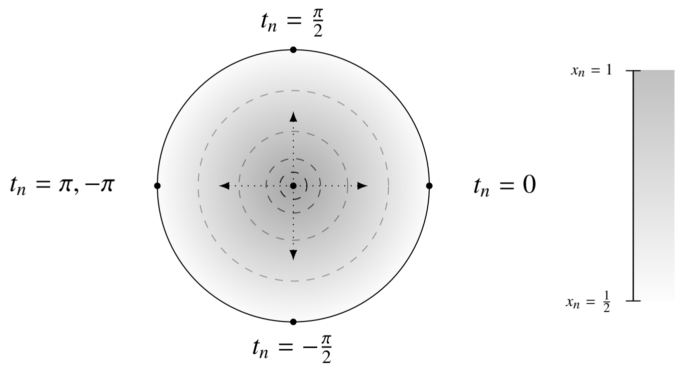

FIGURE 2: Mapping the firm's problem into a location choice

the firm.

Graphically, each editorial strategy (x_n, t_n) corresponds to a location on a disk with unit radius, as illustrated in Figure 2. In contrast to the familiar Salop (1979) model of product differentiation, firms can locate in the interior of the disk. For example, a firm could locate at the center of the disk by setting $x_n = 1$, which corresponds to choosing a maximally generalist editorial strategy. Such a firm would offer a signal that is informative only about the valence component. When instead $x_n < 1$, the firm specializes by locating away from the center in the direction indicated by t_n. Such a firm would be offering a signal that is informative also about the two ideological components, which are weighted in a way that is perfectly aligned with the ideological preference of type t_n.

The transformation to polar coordinates also simplifies the expression of the value of information. It easy to show that it is strictly dominated for firm n to choose an editorial strategy (x_n, t_n) such that $x_n < 1/2$, irrespective of t_n.[9] Therefore, without loss of generality, we restrict attention to editorial strategies that satisfy $x_n \geq 1/2$. In light of this, the value of information can be written as:

$$v((x_n, t_n) \mid t_i) = \lambda\Big(\sqrt{x_n} + \sqrt{1 - x_n}\cos(t_i - t_n)\Big) \tag{2}$$

where $\lambda = \frac{1}{2I\sqrt{\pi}}$. This expression is not only more tractable than the one in Lemma 2, but it is also easier to interpret. Net of the scaling factor λ, the value of information is the sum of two terms. The first term, $\sqrt{x_n}$, refers to the valence component of the policy. This term is independent of the agent's type t_i and is increasing in x_n—how generalist the firm is. Intuitively, since all agents care about the valence component, an information structure that is more informative about the valence component, i.e. sets a higher x_n, will benefit *all* agents, irrespective of their types. The second term, $\sqrt{1 - x_n}\cos(t_i - t_n)$, refers to the ideological components of the pol-

[9] Lemma A2 in Appendix A proves both claims.

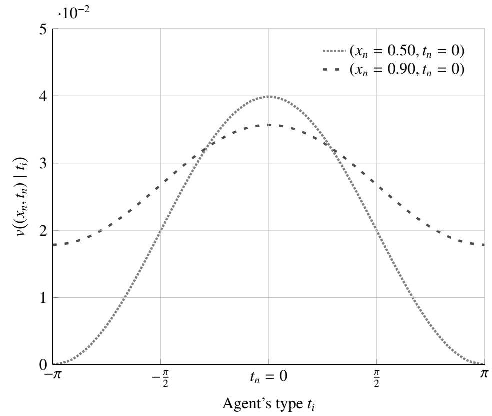

FIGURE 3: The Value of Information Induced by two Editorial Strategies (if $I = 10$)

icy. This term is decreasing in x_n and depends on the agent's type t_i as well as the firm's target t_n. The lower x_n, the more specialized the firm's editorial strategy is, the more informative it is about a specific mixture of ideological issues. This mixture is determined by t_n and its value depends on $\cos(t_i - t_n)$, which represents the correlation in how agent t_i and target t_n evaluate the ideological dimensions of policy. Intuitively, the closer the agent is to the firm's target, the higher the value she attaches to its information.

Equation (2) clarifies the trade-off that firms face when setting their editorial strategies. By being more generalist, a firm generates relatively high value even for types that are far away from its chosen target. By being more specialized, instead, the firm generates relatively higher value only to the types who are ideologically close to its target, alienating the others. Figure 3 exemplifies the trade-off between two strategies, both of which target the type $t_n = 0$. The dotted gray line has a low x_n and, hence, it is highly specialized. It creates high value for the targeted type and the types nearby, but it creates a low value for agents that are farther away. The dashed dark line has a high x_n and, hence, it is more generalist. The value it induces is relatively flatter: By being informative about valence, it generates value for all agents, even those who are ideologically distant from the targeted agent t_n.

What is the *first-best* editorial strategy (x_n, t_n) for an agent of type t_i? From Equation 2, it is easy to see that firm n maximizes the value of information for type t_i by directly targeting this type—i.e., $t_n = t_i$—and assigning equal weight to valence and ideology—i.e., $x_n = 1/2$. By doing so, the firm induces a signal that is maximally correlated (given the firm's constraints) with agent i's utility $u(\omega, t_i)$. Let us denote such first-best value by $\bar{\mathcal{V}} = v((1/2, t_i)|t_i)$ and observe that it is independent of t_i. Note that any editorial strategy with $x_n < 1/2$ would be overly specialized on ideology, even for the targeted type t_n. For this reason, in Figure 2, $x_n = 1/2$ corresponds to the outer border of the disk: We can think of agents as lying on this border, as each one of its points represents the optimal editorial strategy for some type of agent.

Finally, the spatial interpretation that we discussed in this section is convenient to characterize the equilibrium of the game, as we do in the next result.[10]

Theorem 2 (Uniqueness)**.** *Fix $N \geq 1$. There is a unique $x^\star(N) \in [1/2, 1]$ such that, for all equilibria $(x_n, t_n)_{n=1}^N$, $x_n = x^\star(N)$ and $|t_n - t_m| \geq 2\pi/N$, for all firms n and m.*

In equilibrium, all firms are equally specialized and the degree of specialization, $1 - x^\star(N)$, is uniquely pinned down by N. Graphically, this means that firms locate equidistantly from the center of the disk. Moreover, firms' editorial strategies satisfy $|t_n - t_m| \geq 2\pi/N$, for all n and m. Graphically, this means that firms are maximally spread out on one of the inner circles of the disk. Clearly, due to the symmetry in the first-stage game and the fact that the type distribution is uniform, any relabeling of firms' names or rotation in their locations also constitutes an equilibrium. Nonetheless, this multiplicity is immaterial for our main results, as the $x^\star(N)$—how generalist firms are in equilibrium—is uniquely pinned down in equilibrium.

4. Competition, Disagreement, and Welfare

We exploit the convenient equilibrium characterization discussed in Section 3 to analyze how firms and agents' equilibrium behavior change as the market for news becomes more competitive. We divide our analysis into four parts. We study how an increase in N affects: (1) The kind of information that firms supply in equilibrium; (2) The value and the price of information; (3) The distribution of agents' opinions; (4) The welfare of the agents.

4.1. Competition and the Supply of Information

We begin by characterizing the effects of competition on *firms*' equilibrium behavior and, in particular, on the information they supply. We study the effects of competition by comparing equilibria as the number N of firms in the market increases. We show that, as the market becomes more competitive, a firm's optimal response is to specialize. Importantly, this "informational" specialization takes a specific form: Firms specialize by providing relatively less information on the valence component, which is the common-interest component in agents' preferences.

[10]For any $t_i \in T$ and scalar $\alpha \in \mathbb{R}$, we write $t_i + \alpha$ to indicate the sum on the circle, that is a sum (mod π). For example, if $t_i = \pi/2$ and $\alpha = 3\pi/2$, $t_i + \alpha = 0 \in T$.

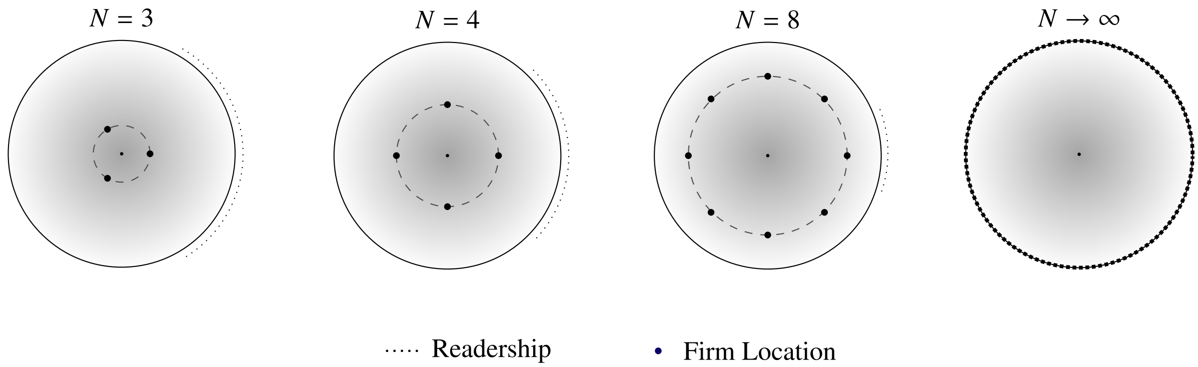

FIGURE 4: Equilibrium in the Information-Provision Stage

Proposition 1. *The equilibrium $x^\star(N)$ is strictly decreasing in N. That is, as competition increases, firms specialize by becoming less informative about the valence component of the policy.*

As the market for news becomes more competitive, it becomes increasingly harder for firm n to compete for types that are farther away from its target t_n. Indeed, in equilibrium, the firm's expected readership is an arc of length $2\pi/N$ centered around the firm's target type t_n. As N increases, the firm's readership shrinks and, thus, it becomes increasingly homogeneous from an ideological point of view. Expecting to face a more homogeneous set of readers, the firm reacts by further specializing—x_n decreases—and thus provides relatively more information on the ideological components of the policy. Graphically, as N increases, firms locate farther away from the center of the disk, as Figure 4 illustrates.

The equilibrium mechanism underlying Proposition 1 can be understood as an information-theoretic counterpart to the more standard idea of product differentiation. Differentiation is a ubiquitous feature of competition games with heterogeneous consumers. Our model is no exception. However, how do firms differentiate when they are selling information? Our result shows that this is achieved by firms increasing the relative informativeness of private-interest components at the expense of common-interest ones.

4.2. Competition and the Value of Information

The previous section illustrated how the equilibrium supply of information changes as competition increases. What are the consequences of this change on agents' behavior? In this section, we highlight the *positive* effects of increased competition in the market for news. We focus attention on two main equilibrium objects: the value of information and its price.

We begin by taking the *ex-ante* perspective of an agent whose type has not yet realized.[11] More precisely, fix an arbitrary equilibrium with N firms and, in such equilibrium, let $n(t_i)$ denote the firm from which t_i acquires information. Given this, let $\mathcal{V}(N) = \mathbb{E}_{t_i}(v((x^\star(N), t^\star_{n(t_i)})|t_i))$ be the expected value for the information that agent i acquires in equilibrium. Similarly, let $\mathcal{P}(N) = \mathbb{E}_{t_i}(p^\star_{n(t_i)}(t_i))$ be its expected price. Note that $\mathcal{V}(N)$ and $\mathcal{P}(N)$ are uniquely pinned down as a function of N—via $x^\star(N)$—and thus do not depend on other features of the equilibrium. We establish the following results.

Proposition 2.

(*a*) *$\mathcal{V}$ is strictly increasing in N. That is, as competition increases, each agent expects to acquire information that is more valuable to her.*

(*b*) *$\mathcal{P}$ is strictly decreasing in N. That is, as competition increases, each agent expects to pay less for the information she acquires.*

The first bullet in this result speaks to the classic view that sees the market for news as a "marketplace of ideas," which promotes knowledge and the discovery of truth (Posner, 1986). Competition pushes firms to provide information that is increasingly catered to the specific informational needs of each agent. With such information, each agent can better sway the policy outcome in the direction of her own preferences and, for this reason, she attaches a higher value to it. Furthermore, while each agent obtains better information from the market, she expects to pay a lower price, as established in the second part of the Proposition 2. As a consequence, industry profits decline.

When the number of firms tends to infinity, the market becomes perfectly competitive. In this limit, we show that *each* type t_i acquires her first-best information structure, thus achieving the highest possible value $\bar{\mathcal{V}}$. Moreover, she pays a price of zero for it. More precisely, fix an arbitrary equilibrium with N firms and let $\mathcal{V}(N|t_i) = v((x^\star(N), t^\star_{n(t_i)})|t_i)$ be the value for the information that type t_i acquires in equilibrium. Similarly, let $\mathcal{P}(N|t_i) = p^\star_{n(t_i)}(t_i)$ be its equilibrium price. While $\mathcal{V}(N|t_i)$ and $\mathcal{P}(N|t_i)$ do depend on the specific equilibrium that we fixed, their respective limits do not.

Remark 2 (Daily-me)**.** *Fix a type t_i. Type t_i's equilibrium value of information converges to the first best,* $\lim_{N\to\infty}\mathcal{V}(N|t_i) = \bar{\mathcal{V}}$*. Moreover, type t_i's equilibrium price converges to zero,* $\lim_{N\to\infty}\mathcal{P}(N|t_i) = 0$.

[11] We state some of the results in this section from this ex-ante perspective. In this way, they are robust to the uninteresting equilibrium multiplicity that is generated, for example, by rotating firms' locations. Nonetheless, a conceptually similar result holds also conditional on a specific type, as demonstrated by Remark A1.

We refer to this limit result as the *daily-me* paradigm, a situation in which every consumer in a perfectly competitive market can find an information structure that is exactly tailored to her specific informational needs (Sunstein, 2001). That is, as the market becomes more competitive, the equilibrium value of information for each agent t_i converges to the highest possible value. It is as if each type t_i could freely choose an editorial strategy (x_n, t_n) to maximize her own value $v((x_n, t_n)|t_i)$. Moreover, the price that the agent pays for such information becomes negligible as the number of firms tends to infinity.[12] In our graphical representation of Figure 4, as $N \to \infty$, firms occupy the whole circumference of the disk, where each point represents the optimal editorial strategy for some type of agent.

These results shed additional light on the equilibrium force behind Proposition 1. They show that the competitive force that pushes firms to specialize, i.e. to decrease x_n, is, in fact, *demand*-driven. As the number of firms grows, each firm serves a progressively smaller set of agents and provides them with an information structure that is increasingly better suited to their specific needs, thus increasing their value of information. This result is in sharp contrast with the main result of Mullainathan and Shleifer (2005) and it is a by-product of the fact that our agents are Bayesian. Moreover, competition in our model does not lead to *over-specialization* as shown in Remark 2. As N grows large, firm n decreases x_n only insofar as it makes its readers better off. Incidentally, this explains why no firm has an incentive to deviate back towards the center of the disk by choosing a generalist editorial strategy: Since agents consider the signal they acquire in equilibrium to be under-specialized relative to their first-best, an editorial strategy that is highly generalist cannot be enticing for them.

4.3. Competition and Social Disagreement

In the previous section, we established that a more competitive market for news enables agents to learn more effectively about the components of the policy they care about. Moreover, they do so by paying a lower price. While this is inherently a positive effect on the individual level, it has negative repercussions on a social level. Indeed, agents become more informed about increasingly different aspects of the policy—the different mixtures of ω_1 and ω_2—at the expense of the valence component ω_0. As we illustrate next, a natural consequence of this is that agents' opinions on the policy become increasingly uncorrelated, thus increasing social disagreement.

[12] Note that $\mathcal{V}(N|t_i)$ and $\mathcal{P}(N|t_i)$ are the interim versions of $\mathcal{V}(N)$ and $\mathcal{P}(N)$, respectively. Therefore, in light of Proposition 2, Remark 2 implies that $\mathcal{V}(N) \nearrow \bar{\mathcal{V}}$ and $\mathcal{P}(N) \searrow 0$.

More precisely, fix an arbitrary equilibrium with N firms and suppose that, in such equilibrium, type t_i acquires information from firm n, thus observing the realization of signal $s_i^\star(\omega) = s(\omega, (x^\star(N), t_n^\star))$. Conditional on such a signal, let $z_i(t_i) = \mathbb{E}_\omega(u(\omega, t_i)|s_i^\star(\omega))$ be the expected utility that type t_i associates with the implementation of the policy. We refer to $z_i(t_i)$ as type t_i's equilibrium *opinion* about the policy. As shown in Lemma 1, the agent approves the policy if she has a positive opinion about the policy and disapproves otherwise. A society where agents' opinions are highly correlated is a society where agreement is high. Motivated by this, we define *social agreement* as the ex ante correlation in the opinions of two agents, i and j, that is $\mathcal{S}(N) = \mathbb{E}_{t_i,t_j}(\mathrm{Corr}(z_i(t_i), z_j(t_j)))$. Intuitively, a society features high social agreement if it is relatively common to find agents whose opinions about the policy are highly correlated.

Proposition 3. *$\mathcal{S}$ is strictly decreasing in N. That is, social agreement decreases with competition.*

The intuition for this result is simple and it is best conveyed by looking at an extreme example. Consider agents i and j with $t_i = 0$ and $t_j = \pi/2$. Among the ideological components of the policy, the former cares exclusively about ω_1, while the latter cares exclusively about ω_2. When competition is low, equilibrium editorial strategies are more generalist—$x^\star(N)$ is high. That is, even if these two agents acquire information from different news outlets, their signals are highly informative about the common valence component ω_0, about which they both care. As a consequence, their opinions $z_i(t_i)$ and $z_j(t_j)$ are highly correlated. When N grows large, $x^\star(N)$ decreases, and both agents can find information that is increasingly tailored to their specific needs. In particular, agent i can learn relatively more about ω_1, while agent j can learn relatively more about ω_2. As a consequence, their opinions depend relatively less on the common component ω_0, and relatively more on ω_1 and ω_2, which are independent aspects of the policy. Hence, their opinions become less correlated.

Proposition 3 summarizes an important aspect of the equilibrium mechanism. It is perhaps not surprising to see that agents are more likely to disagree, provided that agents do receive information about increasingly different combinations of ω_1 and ω_2. The subtlety is that there is in principle a multitude of different ways in which competition could affect the information supplied in equilibrium. Our model demonstrates that, due to the natural interplay between agents' incentives to learn and firms' incentives to maximize profits, competition pushes firms to provide relatively more information precisely about those dimensions on which agents disagree more. This gives rise to a social inefficiency that we document in the next section.

4.4. Competition and its Welfare Consequences

In this section, we conclude our analysis of the effects of competition by studying how increased disagreement ultimately affects agents' welfare. Our main result is to show that, in large enough societies, competition strictly decreases the ex-ante welfare of the agents. To this purpose, fix an equilibrium of the game with N firms. Denote by $a_i^\star(\omega, t_i)$ the approval decision of type t_i conditional on the information that she receives in equilibrium. This random variable takes value 1 if the agent approves the policy and zero otherwise. The equilibrium approval rate is then $A^\star(\omega, t) = \frac{1}{I}\sum_i a_i^\star(\omega, t_i)$, namely, the fraction of agents who approve the policy. By assumption, this also corresponds to the probability that the society implements policy ω. Using this, we write the *ex ante welfare* of an agent as $\mathcal{U}(N) = \mathbb{E}_{\omega,t}(A^\star(\omega, t)u(\omega, t_i) - p^\star(t_i))$. This expression captures *both* the utility that the agent expects to receive from the implemented policy and the disutility associated with the price that she expects to pay for the information she will acquire in equilibrium. The following result characterizes the effects of competition on the agent's welfare.

Proposition 4. *There exists $\bar{I}$ such, that for all societies with $I > \bar{I}$, $\mathcal{U}$ is strictly decreasing in N. That is, as competition increases, the agent's welfare decreases.*

Competition has an overall negative effect on an agent's welfare, despite the positive effects previously highlighted by Proposition 2. To provide intuition for this result, it is useful to decompose the agent i's welfare $\mathcal{U}(N)$ and consider separately agent i's own impact on the policy outcome and the impact of all other agents. Specifically[13], we have

$$\mathcal{U}(N) = \mathcal{V}(N) + \mathcal{G}(N) - \mathcal{P}(N). \tag{3}$$

The first term $\mathcal{V}(N)$ is the expected value of information, which is familiar from Section 4.2. In the proof, we show that it can be equivalently written as $\mathcal{V}(N) = \frac{1}{I}\mathbb{E}_{\omega,t_i}(a_i^\star(\omega, t_i)u(\omega, t_i))$. That is, the expected value of information is equal to the impact of agent i's own approval decision $a_i^\star(\omega, t_i)$ on her utility. The second term of the decomposition is $\mathcal{G}(N) = \frac{1}{I}\mathbb{E}_{\omega,t}(\sum_{j\neq i} a_j^\star(\omega, t_j)u(\omega, t_i))$. It captures the impact that *others'* approval decisions have on agent i's utility. Such approval decisions are based on the information that these agents acquire for themselves. The last term, $\mathcal{P}(N)$, is also familiar from Section 4.2 and captures the expected price that agent i pays for the information she acquires.

[13]This follows from the definition of $\mathcal{U}(N) = \mathbb{E}_{\omega,t}(A^\star(\omega, t)u(\omega, t_i) - p^\star(t_i))$ and the fact that the approval rate $A^\star(\omega, t)$ can be written as the sum of i's impact on the policy outcome, $\frac{1}{I}a_i^\star(\omega, t_i)$, and the impact of all other agents, $\frac{1}{I}\sum_{j\neq i} a_j^\star(\omega, t_j)$. See the proof of Proposition 4 for more details.

This decomposition reveals the key aspects of the equilibrium mechanism highlighted in this paper. The proof of Proposition 4 shows that while competition increases $\mathcal{V}(N)$—the *direct* value that agent i derives from the information supplied by the market—it also leads to a decline in $\mathcal{G}(N)$—its *indirect* value. Note that each agent acquires information to sway, with her approval decision, the policy outcome in the direction of her own preferences, taking as given the behavior of others. For this reason, what ultimately affects the agent's information-acquisition strategy, and thus the firms' profits, is the impact such information has on the policy outcome, whose value is captured by $\mathcal{V}(N)$. From this perspective, it is not surprising that $\mathcal{V}(N)$ is strictly increasing in N, as shown in Proposition 2. The market provides what consumers demand. However, agent i's utility is also affected by the approval decisions of the *other* agents and, thus, by the information that they acquire for themselves. This is captured by $\mathcal{G}(N)$. This term is positive because agents' preferences are after all correlated with each other via the valence component of the policy, ω_0. Thus, others' approval decisions are likely to benefit agent i. However, as competition increases, agents acquire information that is increasingly tailored to their own needs, shifting focus from common-interest components, such as valence, to private-interest components, such as ideology. As a consequence, disagreement increases and it becomes less likely that other's approval decisions benefit agent i. This effect is captured by the fact that $\mathcal{G}(N)$ decreases in N.

Whenever $I \geq 3$, the overall effect is negative and $\mathcal{V}(N) + \mathcal{G}(N)$ decreases (as shown in Remark A2). That is, as competition increases, the total—i.e., direct and indirect—value of the information supplied by the market decreases.[14] This overall effect naturally depends on how consequential an agent's own approval decision is for the policy outcome. This depends on I, the number of agents in the society. In larger societies, agent i's own decision is less consequential for the final outcome, while other agents' decisions become more relevant. It is important to ask whether the negative effect highlighted above can be ultimately compensated by the fact that competition brings about lower prices to all agents (Proposition 2). Proposition 4 shows that when I is sufficiently large, the decrease in price is unable to compensate for the loss of utility generated by the informational externality.[15]

In conclusion, Proposition 4 highlights how competition in the market for *political* news can have very different consequences than in other, more traditional markets. Our model illustrates how political information differs from other types of products. Political information has value

[14] Note that $\mathcal{V}(N) + \mathcal{G}(N)$ is also a measure of *social welfare* (agents and firms), since prices are transfers of resources from agents to firms.

[15] This is not a limit result. On the contrary, $\bar{I} = 3(1 + 2\pi)$ is rather small.

because it allows agents to influence electoral outcomes in a way that aligns with their own personal preferences. However, by definition, electoral outcomes represent collective decisions that have consequences for all members of the society. This implies that individual information-acquisition strategies have social externalities on others, which are exacerbated by the increase in competition.

Complete-Information Benchmark. We conclude this section by highlighting a final result that further illustrates the inefficiency captured by Proposition 4. To do so, we focus attention on two special sets of policies ω, for which either $u(\omega, t_i) > 0$ for all t_i or $u(\omega, t_i) < 0$ for all t_i. Let us denote them by Ω^+ and Ω^-, respectively. The policies in these sets are special in that, if the society could perfectly learn ω, agents would unanimously agree on its approval, if $\omega \in \Omega^+$, or disapproval, if $\omega \in \Omega^-$. Recall that $A^\star(\omega, t)$ is the equilibrium approval rate conditional on policy ω and the profile of agents' types t. It also corresponds to the probability that the society implements policy ω. Hence, when $\omega \in \Omega^+$ the policy is "correctly" implemented with probability $A^\star(\omega)$; and equivalently when $\omega \in \Omega^-$ the policy is "correctly" implemented with probability $1 - A^\star(\omega)$ relative to the complete information benchmark. From an ex ante perspective, the probability the society correctly implements policies in Ω^+ (resp. Ω^-) is given by $\mathbb{E}_\omega(A^\star(\omega, t)|\omega \in \Omega^+)$ (resp. $\mathbb{E}_\omega(1 - A^\star(\omega, t)|\omega \in \Omega^-)$). The next result shows that these terms are decreasing in N, irrespective of the equilibrium that is played by firms and agents.

Remark 3. *The probability that a policy in Ω^+ or Ω^- is correctly implemented by the society is strictly decreasing in N.*

This result allows us to formalize the following idea. In our model ignorance is not bliss. Rather, there is plenty of scope for information to play a positive role, for example by allowing agents to collectively identify policies that are uncontroversially good for them. However, the market does not provide such information to the agent. Indeed, as competition increases, the society is less likely to correctly implement even this class of policies on which there would be full agreement under the complete information benchmark. This result points to how pervasive is the inefficiency in the policy selection that is highlighted by the mechanism of this paper.

5. Extensions

In this section, we discuss how to generalize our main results beyond some of the simplifying assumptions of our model. This exercise allows us to better appreciate the role of two key ingredients in our model: the heterogeneity in agents' preferences and the constraints on how much agents can learn about the policy.

5.1. Preference Heterogeneity

In our baseline model, we assumed agents' types to be uniformly distributed over the unit circle. This assumption endows the model with symmetry: In equilibrium, firms spread out evenly on an inner circle of the disk. This allows us to pin down the equilibrium behavior of firms and agents for *all* levels of competition in the market, irrespective of the number of firms N. With this, we can clearly demonstrate the mechanism that leads firms to change their editorial strategies as N increases, and how such a change affects social welfare. In this section, we drop this distributional assumption and consider a larger class of distributions over agents' types, that are symmetric around a "median" type t^m and bounded away from zero.

Definition 1. *The distribution F is* regular *if its density satisfies the following properties: (1) a type $t^m \in T$ exists such that for any $\delta > 0$, $f(t^m + \delta) = f(t^m - \delta)$; (2) there exists a $C > 0$ such that $f(t_i) > C > 0$ for all t_i.*

Clearly, the uniform distribution is regular. More generally, regular distributions allow for a wider range of heterogeneity in agents' ideological preferences. Once we move beyond the uniform distribution, due to the lack of symmetry, it is no longer tractable to solve for equilibrium behavior under an *arbitrary* number of firms N. Nonetheless, we show that the main insights of the paper still hold under this more general class of distributions by comparing two notable cases: the monopoly case, where $N = 1$, and the perfect competition case, where $N \to \infty$.

Proposition 5. *Fix a regular distribution F.*

a. *(Existence) An equilibrium exists for any $N \geq 1$ and $I \geq 1$.*
b. *(Daily-me) Fix any t_i. As $N \to \infty$, the equilibrium value of information for type t_i, $\mathcal{V}(N|t_i)$, converges in probability to the first-best value $\bar{\mathcal{V}}$.*
c. *(Inefficiency) There exists $\bar{I}$ such that for all societies with $I > \bar{I}$ agents, the agent's welfare is higher in a monopoly than under perfect competition, i.e. $\mathcal{U}(1) > \lim_{N\to\infty} \mathcal{U}(N)$.*

There are three results. First, we establish the existence of an equilibrium with an arbitrary number of firms. Such an equilibrium involves possibly mixed editorial strategies in the first stage of the game. Second, we demonstrate that, as the market becomes perfectly competitive, every agent can acquire information that is perfectly tailored to her specific needs. Thus, the daily-me paradigm (Remark 2) holds even in this more general setup. The intuition is simple:

As the market becomes more competitive and profits decline, firms find it optimal to target under-served types who are not able to find information close to their first-best. Third, we show that competition decreases agents' welfare relative to the monopoly benchmark. That is, the inefficiency highlighted by Proposition 4 remains present under this broader class of distributions.

To provide intuition for this latter result, let us recall from the previous section that the agent's welfare can be decomposed into three terms: the *direct* value of information $\mathcal{V}$, the *indirect* value of information $\mathcal{G}$, and its associated price $\mathcal{P}$. As noted in Section 4.2, a perfectly competitive market delivers the daily-me paradigm, generating the first-best value for $\mathcal{V}$. Furthermore, competition drives prices towards zero. Both of these forces unequivocally increase the agent's welfare. Yet, we show that $\mathcal{G}(1) > \lim_{N\to\infty} \mathcal{G}(N)$. To understand why, recall that $\mathcal{G}$ captures the utility that an agent derives from the approval decisions of *other* agents and, thus, from the information that these agents acquire. As others become better informed about increasingly different aspects of the policy, their approval decisions become less likely to be aligned with the preferences of an arbitrary agent; and, thus, the indirect value of information decreases.[16] Given this, the result in Proposition 5 follows from the fact that the direct value of information $\mathcal{V}$ decreases in the size of the society I—since one's approval decision becomes less consequential—whereas the indirect value of information $\mathcal{G}$ increases in I.

The proof of Proposition 5 also clarifies the connection between the inefficiency highlighted in this paper and one of the main features of our model, namely the heterogeneity in agents' preferences. Intuitively, the decline in $\mathcal{G}$ is more pronounced—i.e., the inefficiency is higher—the higher is the heterogeneity in agents' preferences. To formalize this, let us define $\beta_F := \int \cos(t^m - t_i) f(t_i) \in [0, 1)$, a statistics of the distribution F. It represents the expected correlation between the ideological preferences of an arbitrary agent and the median type t^m. As such, it measures the degree of *homogeneity* in the agents' preferences. For example, when F is uniform, as in our baseline model, $\beta_F = 0$ and the society is maximally heterogeneous. In contrast, when F approaches a degenerate distribution centered around t^m, $\beta_F \to 1$ and the society is maximally homogeneous. The proof of Proposition 5 shows that $\mathcal{G}(1) - \lim_{N\to\infty} \mathcal{G}(N)$, and hence, $\mathcal{U}(1) - \lim_{N\to\infty} \mathcal{U}(N)$, decreases in β_F. That is, the lower the β_F, the larger the welfare decline as we transition from the monopoly to perfect competition. From this perspective, we note that our baseline model—in which F is uniform and, thus, $\beta_F = 0$—constitutes an ex-

[16] In Remark B1 in Appendix B.1, we show that the monopolist maximizes exactly $\mathcal{G}$. To gain intuition, note that the information structure that maximizes $\mathcal{G}$ must induce approval decisions that maximize the utility for an arbitrary agent. But the monopolist, due to the lack of competition, shares the same goal, i.e. the monopolist chooses an editorial strategy to maximize value for an arbitrary agent.

treme benchmark, providing the most acute demonstration of the inefficiency associated with competition.

5.2. Multimedia

Another important assumption of our model is that each agent can acquire a signal from only one firm. In Appendix B.2, we illustrate how a model of multimedia—in which agents acquire information from multiple firms—can preserve the main insights of our analysis. In such a model, each agent is endowed with a unit of time that she can divide among the N firms. We assume that the agent then observes a single signal realization, whose distribution is a mixture of those induced by the firms' signals, with weights determined by the agent's information-acquisition strategy. When the agent allocates all of her time to one firm, this formulation reduces to our baseline model.

From a technical point of view, the main challenge in such a model is to determine firms' profits. To make the model tractable, we make a reduced-form assumption: A firm's profit is proportional to the *surplus* that the firm generates for each agent, namely the difference between the agent's first-best value and the second-best she could have obtained in the absence of this firm (mirroring Equation (1) in the baseline model). Using such a setup, we outline how Proposition 5 can be extended to allow for multimedia.

From a qualitative point of view, this model of multimedia allows the agent to mix among multiple firms to "construct" signals that are better tailored to her own needs, even when these are not directly supplied by the market. Despite allowing for more freedom, this extension retains one of the key ingredients in our model, namely the fact that agents are constrained in how much they can learn about the policy. This kind of constraint and its interaction with heterogeneity in agents' preferences drives informational specialization in our model, which lies at the heart of the inefficiency identified in this paper.

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A. Proofs

A.1. Proofs for Section 3

A.1.1. Equilibrium Characterization

Proof of Lemma 1. Fix an arbitrary profile of editorial strategies $(b_1, \ldots, b_N)$. Consider an arbitrary profile of approval strategies for agents other than i, $a_j(\omega, \theta_j)$ for $j \neq i$. The latter may depend on their respective choices at the information-acquisition stage. Denote by $A_{-i}(\omega) = I^{-1} \sum_{j \neq i} a_j(\omega, \theta_j)$ the approval rate excluding i. If i approves, the policy is implemented with probability $A_{-i}(\omega) + I^{-1}$. If i disapproves, instead, the policy is implemented with probability $A_{-i}(\omega)$. When the policy is not implemented, i earns 0. Therefore, the value of agent i's problem is equal to

$$\begin{aligned} & \max \Big\{ \mathbb{E}_\omega \Big(A_{-i}(\omega) u(\omega, \theta_i) \Big| s_i(\omega, b_n) = \bar{s}_i \Big), \mathbb{E}_\omega \Big((A_{-i}(\omega) + 1/I) u(\omega, \theta_i) \Big| s_i(\omega, b_n) = \bar{s}_i \Big) \Big\} \\ = \; & \mathbb{E}_\omega \Big(A_{-i}(\omega) u(\omega, \theta_i) \Big| s_i(\omega, b_n) = \bar{s}_i \Big) + I^{-1} \max \Big\{ 0, \mathbb{E}_\omega \Big(u(\omega, \theta_i) \Big| s_i(\omega, b_n) = \bar{s}_i \Big) \Big\} \end{aligned}$$

Therefore, the agent approves the policy if and only if $\mathbb{E}_\omega(u(\omega, \theta_i) | s_i(\omega, b_n) = \bar{s}_i) \geq 0$. □

Proof of Lemma 2. Fix agent i of type θ_i. Consider an arbitrary profile of approval strategies for agents other than i, $a_j(\omega, \theta_j)$ for $j \neq i$. Denote by $A_{-i}(\omega) = I^{-1} \sum_{j \neq i} a_j(\omega, \theta_j)$ the resulting approval rate excluding i. Let us first compute the expected utility if type θ_i does not receive any information.

$$\begin{aligned} & \max \Big\{ \mathbb{E}_\omega \Big(A_{-i}(\omega) u(\omega, \theta_i) \Big), \mathbb{E}_\omega \Big((A_{-i}(\omega) + 1/I) u(\omega, \theta_i) \Big) \Big\} \\ = \; & \mathbb{E}_\omega (A_{-i}(\omega) u(\omega, \theta_i)) + I^{-1} \max \{ 0, \mathbb{E}_\omega (u(\omega, \theta_i)) \} \\ = \; & \mathbb{E}_\omega (A_{-i}(\omega) u(\omega, \theta_i)) \end{aligned}$$

The last equality holds because $\mathbb{E}_\omega(u(\omega, \theta_i)) = 0$, since $\mathbb{E}_\omega \omega_k = 0$ for $k \in \{0, 1, 2\}$. Next, we compute agent i's ex ante utility when she observes a signal induced by b_n:

$$\begin{aligned} & \mathbb{E}_{\bar{s}_i} \Big(\max \Big\{ \mathbb{E}_\omega \Big(A_{-i}(\omega) u(\omega, \theta_i) \Big| s(\omega, b_n) = \bar{s}_i \Big), \mathbb{E}_\omega \Big((A_{-i}(\omega) + 1/I) u(\omega, \theta_i) \Big| s(\omega, b_n) = \bar{s}_i \Big) \Big\} \Big) \\ = \; & \mathbb{E}_{\bar{s}_i} (\mathbb{E}_\omega (A_{-i}(\omega) u(\omega, \theta_i) \Big| s(\omega, b_n) = \bar{s}_i)) + I^{-1} \mathbb{E}_{\bar{s}_i} (\max \{ 0, \mathbb{E}_\omega (u(\omega, \theta_i) \Big| s(\omega, b_n) = \bar{s}_i) \}) \end{aligned}$$

We analyze the two components of this sum separately. By the law of iterated expectations, we have that the first component is

$$\mathbb{E}_{\bar{s}_i} (\mathbb{E}_\omega (A_{-i}(\omega) u(\omega, \theta_i) \Big| s(\omega, b_n) = \bar{s}_i)) = \mathbb{E}_\omega (A_{-i}(\omega) u(\omega, \theta_i))$$

For the second component, let us first note that $u(\omega, \theta_i) \sim \mathcal{N}(0, ||\theta_i||)$ and $s_i(\omega, b_n) = b_n \cdot \omega + \varepsilon_i \sim \mathcal{N}(0, 1 + ||b_n||)$. By the property of conditional expectations under normal distributions we have that:

$$\begin{aligned} \mathbb{E}_\omega (u(\omega, \theta_i) \Big| s(\omega, b_n) = \bar{s}_i) &= \frac{\theta_i \cdot b_n}{\sqrt{||\theta_i||(1 + ||b_n||)}} \frac{\sqrt{||\theta_i||}}{\sqrt{1 + ||b_n||}} \bar{s}_i \\ &= \frac{\theta_i \cdot b_n}{1 + ||b_n||} \bar{s}_i \sim \mathcal{N} \Big(0, \frac{(\theta_i \cdot b_n)^2}{1 + ||b_n||} \Big) \end{aligned} \tag{A1}$$

That is, once we account for the ex ante randomness of $\bar{s}_i$, the interim expectation $\mathbb{E}_\omega(u(\omega,\theta_i)\big|s(\omega,b_n) = \bar{s}_i)$ is itself a random variable that is normally distributed. Therefore,

$$\mathbb{E}_{\bar{s}_i}\big(\max\{0, \mathbb{E}_\omega(u(\omega,\theta_i)\big|s(\omega,b_n) = \bar{s}_i)\}\big) = \frac{1}{2}\mathbb{E}_{\bar{s}_i}\big(\big|\mathbb{E}_\omega(u(\omega,\theta_i)\big|s(\omega,b_n) = \bar{s}_i)\big|\big)$$

where the latter is the expectation of the absolute value of a normal distribution with mean zero and variance as defined above. As such, we know that

$$\frac{1}{2}\mathbb{E}_{\bar{s}_i}\big(\big|\mathbb{E}_\omega(u(\omega,\theta_i)\big|s(\omega,b_n) = \bar{s}_i)\big|\big) = \frac{1}{2}\frac{\sqrt{2}}{\sqrt{\pi}}\sqrt{\frac{(\theta_i\cdot b_n)^2}{1+\|b_n\|}} = \frac{|\theta_i\cdot b_n|}{\sqrt{2\pi(1+\|b_n\|)}}$$

Therefore, the value of information induced by b_n for an agent of type θ_i is

$$\begin{aligned} v(b_n|\theta_i) &= \mathbb{E}_\omega(A_{-i}(\omega)u(\omega,\theta_i)) + \frac{|\theta_i\cdot b_n|}{I\sqrt{2\pi(1+\|b_n\|)}} - \mathbb{E}_\omega(A_{-i}(\omega)u(\omega,\theta_i)) \\ &= \frac{|\theta_i\cdot b_n|}{I\sqrt{2\pi(1+\|b_n\|)}}. \end{aligned}$$

This concludes the proof. □

Lemma A1. *It is never optimal for a firm to choose a strategy b_n such that $\|b_n\| < 1$.*

Proof of Lemma A1. Let b_n be such that $\|b_n\| < 1$. We show that there exists a b_n' such that, for all θ_i, $v(b_n'|\theta_i) > v(b_n|\theta_i)$. Define $c = \|b_n\|^{-1/2} > 1$ and $b_n' = cb_n$. Notice that $\|b_n'\| = 1$ and $|\theta_i b_n'| = c|\theta_i b_n|$. By Lemma 2,

$$\begin{aligned} v(b_n|\theta_i) &= \frac{|\theta_i\cdot b_n|}{I\sqrt{2\pi}}\frac{1}{\sqrt{1+\|b_n\|}} \\ &< \frac{|\theta_i\cdot b_n|}{I\sqrt{2\pi}}\frac{1}{\sqrt{\|b_n\|+\|b_n\|}} = \frac{|\theta_i\cdot b_n|}{I\sqrt{2\pi}}\frac{1}{\sqrt{2}\sqrt{\|b_n\|}} \\ &= \frac{|\theta_i\cdot b_n|}{I\sqrt{2\pi}}\frac{c}{\sqrt{2}} = \frac{|\theta_i\cdot b_n'|}{2I\sqrt{\pi}} = v(b_n'|\theta_i). \end{aligned}$$

Therefore, it is without loss of generality to ignore a strategy b_n such that $\|b_n\| < 1$. □

Proof of Remark 1. Fix θ_i. By assumption, $\|\theta_i\| = 2$ and $\theta_{i,0} = 1$. That is $\theta_{i,1}^2 + \theta_{i,2}^2 = 1$ and $(\theta_{i,1},\theta_{i,2})$ is a point on the unit circle. Thus, there exists a unique $t \in T = [0,2\pi]$ such that $(\theta_{i,1},\theta_{i,2}) = (\cos(t_i),\sin(t_i))$. Therefore, $u(\omega,\theta_i) = \omega_0 + \omega_1\theta_{i,1} + \omega_2\theta_{i,2} = \omega_0 + \omega_1\cos(t_i) + \omega_2\sin(t_i)$. Now fix an arbitrary b_n. Clearly,

$$s_i(\omega,b_n) = \omega_0 b_{n,0} + \sqrt{\|b_n\| - b_{n,0}^2}\Big(\omega_1\frac{b_{n,1}}{\sqrt{\|b_n\| - b_{n,0}^2}} + \omega_2\frac{b_{n,2}}{\sqrt{\|b_n\| - b_{n,0}^2}}\Big) + \varepsilon_i.$$

Moreover, $\frac{b_{n,1}^2}{\|b_n\|-b_{n,0}^2} + \frac{b_{n,2}^2}{\|b_n\|-b_{n,0}^2} = 1$. Therefore, $\big(\frac{b_{n,1}}{\sqrt{\|b_n\|-b_{n,0}^2}}, \frac{b_{n,2}}{\sqrt{\|b_n\|-b_{n,0}^2}}\big)$ is a point on the unit circle and equals $(\cos(t_n),\sin(t_n))$ for a unique $t_n \in T$. Letting $x_n = b_{n,0}^2 \in [0,\|b_n\|]$, we have

$$s_i(\omega,b_n) = \sqrt{x_n}\omega_0 + \sqrt{\|b_n\| - x_n}\Big(\omega_1\cos(t_n) + \omega_2\sin(t_n)\Big) + \varepsilon_i.$$

Setting $||b_n|| = 1$ concludes the proof. □

Lemma A2. *It is never optimal for a firm to choose an editorial strategy* (x_n, t_n) *with* $x_n < 1/2$. *Moreover, the* value of information (x_n, t_n) *when* $x_n \geq 1/2$ *is equal to*

$$v((x_n, t_n) \mid t_i) = \lambda\Big(\sqrt{x_n} + \sqrt{1 - x_n}\cos(t_i - t_n)\Big),$$

where $\lambda = \frac{1}{2I\sqrt{\pi}}$.

Proof of Lemma A2. Fix an arbitrary strategy b_n. By Remark 1 and its proof, notice that

$$|b_n \cdot \theta_i| = \Big|\sqrt{x_n} + \sqrt{1 - x_n}\cos(t_i - t_n)\Big|.$$

To establish this equality, we used the angle-addition identity $\cos(t_n)\cos(t_i) + \sin(t_n)\sin(t_n) = \cos(t_i - t_n)$. It is straightforward to see that for all (x_n, t_n) with $x_n \geq 1/2$, $\sqrt{x_n} + \sqrt{1 - x_n}\cos(t_i - t_n) \geq 0$ for all t_i and t_n. Therefore, whenever $x_n \geq 1/2$, the value of information simplifies to

$$v((x_n, t_n) \mid t_i) = \frac{1}{2I\sqrt{\pi}}\Big(\sqrt{x_n} + \sqrt{1 - x_n}\cos(t_i - t_n)\Big).$$

Now fix (x_n, t_n) with $x_n < 1/2$. We want to show that there is a feasible (x_n', t_n') such that $v((x_n', t_n')|t_i) \geq v(x_n, t_n)|t_i)$, for all t_i. To see this let $x_n' = 1 - x_n > 1/2$ and $t_n' = t_n$. We need to show that

$$\sqrt{1 - x_n} + \sqrt{x_n}\cos(t_i - t_n) \geq \Big|\sqrt{x_n} + \sqrt{1 - x_n}\cos(t_i - t_n)\Big|.$$

Let us first consider the case when the argument in the absolute value is positive. Then,

$$\begin{gathered}\sqrt{1 - x_n} + \sqrt{x_n}\cos(t_i - t_n) \geq \sqrt{x_n} + \sqrt{1 - x_n}\cos(t_i - t_n) \\ (\sqrt{1 - x_n} - \sqrt{x_n})(1 - \cos(t_i - t_n)) \geq 0\end{gathered}$$

Note that $\sqrt{1 - x_n} - \sqrt{x_n} \geq 0$, since $x_n < 1/2$. Therefore, the above inequality holds for all t_i and t_n. Next, we consider the case when the argument in the absolute value is negative. In such case,

$$\begin{gathered}\sqrt{1 - x_n} + \sqrt{x_n}\cos(t_i - t_n) \geq -\sqrt{x_n} - \sqrt{1 - x_n}\cos(t_i - t_n) \\ (\sqrt{1 - x_n} + \sqrt{x_n})(1 + \cos(t_i - t_n)) \geq 0,\end{gathered}$$

which trivially holds for all t_i and t_n. Since $v((x_n, t_n)|t_i) \leq v((1 - x_n, t_n)|t_i)$ for all t_i, the firm can weakly increase its payoff by deviating from (x_n, t_n) to $(1 - x_n, t_n)$. It is therefore with no loss of generality to focus on editorial strategies (x_n, t_n) that have $x_n \geq 1/2$. □

A.1.2. Proof of Theorem 1

Lemma A3. *Let* $x^\star = 1/(1 + (\sin(\pi/N)/\pi/N)^2)$ *and* $x_n \in [1/2, 1]$. *For all* $N \geq 3$, $v((x_n, 0)|2\pi/N) < v((x^\star, 0)|\pi/N)$.

Proof. We begin by noting that

$$\sqrt{x_n} + \sqrt{1-x_n}\cos(2\pi/N) \leq \max_{x_n \in [1/2,1]} v((x_n,0)|2\pi/N) = \begin{cases} 1 & \text{if } N \leq 4 \\ \sqrt{1+\cos^2(2\pi/N)} & \text{if } N \geq 5 \end{cases}$$

Moreover, by substituting the definition of $x^\star$ in $v((x^\star,0)|\pi/N)$ we obtain

$$\sqrt{x^\star} + \sqrt{1-x^\star}\cos(\pi/N) = \frac{2\pi/N + \sin(2\pi/N)}{2\sqrt{(\pi/N)^2 + \sin^2(\pi/N)}}$$

Let $N \in \{3,4\}$. In such case, it is enough to show that

$$1 < \frac{2\pi/N + \sin(2\pi/N)}{2\sqrt{(\pi/N)^2 + \sin^2(\pi/N)}}.$$

This inequality is equivalent to $2\pi/N\cos(\pi/N) - \sin^3(\pi/N) > 0$, which holds for $N \in \{3,4\}$.

Now let $N \geq 5$. In such case, it is enough to show that

$$\sqrt{1+\cos^2(2\pi/N)} < \frac{2\pi/N + \sin(2\pi/N)}{2\sqrt{(\pi/N)^2 + \sin^2(\pi/N)}}.$$

Denoting $y = \pi/N \in (0,\pi/5]$ and simplifying the above inequality, we obtain

$$G(y) = \frac{1}{4}\sin^2(2y) + y\sin(2y) - \sin^2(y) - \cos^2(2y)(y^2 + \sin^2(y)) > 0$$

Note that $G(0) = 0$. To conclude the proof, we will show that $G'(y) > 0$ for all $y \in (0,\pi/5]$. Note that

$$\begin{aligned} G'(y) \quad = \quad & \sin(2y)\cos(2y) + \sin(2y) + 2y\cos(2y) - 2\sin(y)\cos(y) + \\ & 4\cos(2y)\sin(2y)(y^2 + \sin^2(y)) - \cos^2(2y)(2y + 2\sin(y)\cos(y)) \end{aligned}$$

Since $2\sin(y)\cos(y) = \sin(2y)$, the second and fourth term cancel. Moreover,

$$\begin{aligned} G'(y) \quad &= \quad \sin(2y)\cos(2y) + 2y\cos(2y) + \\ & \quad\quad 4\cos(2y)\sin(2y)(y^2 + \sin^2(y)) - \cos^2(2y)(2y + \sin(2y)) \\ &> \quad \sin(2y)\cos(2y) + 2y\cos(2y) + \\ & \quad\quad 4\cos(2y)\sin(2y)(y^2 + \sin^2(y)) - \cos(2y)(2y + \sin(2y)) \\ &= \quad 4\cos(2y)\sin(2y)(y^2 + \sin^2(y)) \\ &> \quad 0. \end{aligned}$$

The first inequality follows from the fact that, since $\cos(2y) \in (0,1)$, $\cos(2y) > \cos^2(2y)$. The last inequality follows trivially, as all terms of the expression are strictly positive. □

Proof of Theorem 1. If $N = 1$, the profit of the (monopolist) firm when choosing editorial strategy (x_1, t_1) is

$$I\int_{-\pi}^{\pi} v((x_1,t_1)|t)dF(t) = I\int_{-\pi}^{\pi} v((x_1,0)|t)dF(t) = I\sqrt{x_1} + I\sqrt{1-x_1}\int_{-\pi}^{\pi}\cos(t)dF(t) = I\sqrt{x_1}.$$

The last inequality follows from the fact that F is the cdf of the uniform distribution on $T = [-\pi, \pi]$. Therefore, $x_1 = x^\star(1) = 1$ maximizes the monopolist's profit.

Now let $N \geq 2$. We divide proof in two parts. First, we establish the existence and uniqueness of $x^\star \in [1/2, 1]$ such that, if the N firms are equidistantly located, no firm n would want to unilaterally deviate by choosing a $x_n \neq x^\star$. Second, we establish that if all firms $n' \neq n$ choose $x_{n'} = x^\star$ and are equidistantly located, firm n does not have incentives to deviate away from $(x^\star, 0)$ to a different strategy (x_n, t_n).

Part 1. Consider a candidate profile of symmetric strategies $(x_n, t_n)_{n=1}^N$. Suppose that locations $(t_n)_{n=1}^N$ are equidistant and, without loss of generality, let $t_n = 0$. Let $x_{n'} = \bar{x} \in [1/2, 1]$ for all $n' \neq n$. Let $V((x_{n'}, t_{n'})_{n' \neq n} | t) = \max\{v((x_{n'}, t_{n'})|t) : n' \neq n\}$. The profit for firm n is equal to:

$$\begin{aligned}\Pi\Big((x_n, t_n = 0), (x_{n'}, t_{n'})_{n' \neq n}\Big) &= I \int_{-\pi}^{\pi} \max\{0, v((x_n, t_n)|t) - V((x_{n'}, t_{n'})_{n' \neq n}|t)\} dF(t) \\ &= I \int_{R_n} v((x_n, t_n)|t) - V((x_{n'}, t_{n'})_{n' \neq n}|t) dF(t)\end{aligned}$$

Notice that readership R_n is equal to the union of finitely-many disconnected intervals $R_n = \cup_{k=1}^K [\bar{t}_l^k, \bar{t}_r^k]$, with K finite, thus:

$$\Pi\Big((x_n, t_n = 0), (x_{n'}, t_{n'})_{n' \neq n}\Big) = I \sum_{k=1}^{K} \int_{\bar{t}_l^k}^{\bar{t}_r^k} v((x_n, t_n)|t) - V((x_{n'}, t_{n'})_{n' \neq n}|t) dF(t) \tag{A2}$$

The derivative of such function with respect to x_n is given by

$$\Pi_{x_n}\Big((x_n, t_n = 0), (x_{n'}, t_{n'})_{n' \neq n}\Big) = I \sum_{k=1}^{K} \frac{d}{dx_n} \int_{\bar{t}_l^k}^{\bar{t}_r^k} v((x_n, t_n)|t) - V((x_{n'}, t_{n'})_{n' \neq n}|t) dF(t)$$

Importantly, for each k,

$$\begin{aligned}\frac{d}{dx_n} \int_{\bar{t}_l^k}^{\bar{t}_r^k} v((x_n, t_n)|t) - V((x_{n'}, t_{n'})_{n' \neq n}|t) dF(t) &= \int_{\bar{t}_l^k}^{\bar{t}_r^k} \frac{d}{dx_n} v((x_n, t_n)|t) dF(t) \\ &= \frac{1}{2\pi}\Big(\frac{1}{2\sqrt{x_n}}(\bar{t}_r^k - \bar{t}_l^k) - \frac{1}{2\sqrt{1 - x_n}}\Big(\sin(\bar{t}_r^k) - \sin(\bar{t}_l^k)\Big)\Big).\end{aligned}$$

The first equality holds because, for $z \in \{l, r\}$, by definition of each threshold type $\bar{t}_z^k$

$$v((x_n, t_n)|\bar{t}_z^k) - V((x_{n'}, t_{n'})_{n' \neq n}|\bar{t}_z^k) = 0.$$

Therefore, all terms in the derivative which have $d\bar{t}_z^k/dx_n$ cancel. Summing up,

$$\Pi_{x_n}\Big((x_n, t_n = 0), (x_{n'}, t_{n'})_{n' \neq n}\Big) = \frac{I}{2\pi}\left(\frac{1}{2\sqrt{x_n}} \sum_{k=1}^{K} (\bar{t}_r^k - \bar{t}_l^k) - \frac{1}{2\sqrt{1 - x_n}} \sum_{k=1}^{K} \Big(\sin(\bar{t}_r^k) - \sin(\bar{t}_l^k)\Big)\right). \tag{A3}$$

Setting $\Pi_{x_n} = 0$ gives the following equilibrium condition:

$$\sqrt{\frac{1 - x_n}{x_n}} = \frac{\sum_{k=1}^{K} \Big(\sin(\bar{t}_r^k) - \sin(\bar{t}_l^k)\Big)}{\sum_{k=1}^{K} (\bar{t}_r^k - \bar{t}_l^k)}.$$

When $x_n = \bar{x}$, $K = 1$, that is, readership is single connected interval. To see this, note that a necessary condition for $K > 1$ is that $v((x_n, t_n = 0)|3\pi/N) > v((\bar{x}, 2\pi/N)|3\pi/N)$ or, equivalently, $v((x_n, t_n = 0)|3\pi/N) > v((\bar{x}, 0)|\pi/N)$. This is ruled out by Lemma A3 and the fact that $v((x_n, t_n = 0)|3\pi/N) < v((x_n, t_n = 0)|2\pi/N)$ in this range. Therefore, the equilibrium condition above simplifies to:

$$\sqrt{\frac{1-\bar{x}}{\bar{x}}} = \frac{\sin(\bar{t}_r) - \sin(\bar{t}_l)}{\bar{t}_r - \bar{t}_l} = \frac{\sin(\bar{t}_r)}{\bar{t}_r} = \frac{\sin(\pi/N)}{\pi/N}. \tag{A4}$$

In the equation above, we dropped the index $k = 1$ for simplicity. In the second equality, we used the fact that, since $(t_n)_{n=1}^N$ are equidistant, $\bar{t}_l = -\bar{t}_r$. Finally, in the last equality, we used the fact that, since $x_n = \bar{x}$, the threshold type $\bar{t}_r$ is π/N. It is immediate to see that this equation has a unique solution $\bar{x} = x^\star \in (1/2, 1)$.

Part 2. To verify that $(x^\star, t_n)_{n=1}^N$ is indeed an equilibrium, we need to make sure there is no profitable deviation (x'_n, t'_n) for firm n, provided that every other firm follows $(x^\star, t_{n'})_{n' \neq n}$. Our strategy is to show that $\Pi_{t_n}((x'_n, t'_n), (x^\star, t_{n'})_{n'\neq n}) < 0$ for arbitrary (x'_n, t'_n) with $x'_n \in [1/2, 1]$ and $t'_n \in (0, 2\pi/N)$. Note that a deviation with $t_n \in (-2\pi/N, 0)$ generates derivations that are symmetric to the one that follows below and therefore we skip them. The derivative of the profit function, as expressed in (A2) is

$$\Pi_{t_n}\Big((x'_n, t'_n), (x^\star, t_{n'})_{n'\neq n}\Big) = I \sum_{k=1}^{K} \frac{d}{dt_n} \int_{\bar{t}_l^k}^{\bar{t}_r^k} v((x'_n, t'_n)|t) - V((x^\star, t_{n'})_{n'\neq n}|t) dF(t)$$

As in Part 1, for each k, the derivative in t_n substantially simplifies and we get:

$$\begin{aligned} \tfrac{d}{dt_n} \int_{\bar{t}_l^k}^{\bar{t}_r^k} v((x'_n, t'_n)|t) - V((x^\star, t_{n'})_{n'\neq n}|t) dF(t) &= \int_{\bar{t}_l^k}^{\bar{t}_r^k} \tfrac{d}{dt_n} v((x'_n, t'_n)|t) dF(t) \\ &= -\tfrac{1}{2\pi} \sqrt{1 - x'_n} \Big(\cos(\bar{t}_r^k - t'_n) - \cos(\bar{t}_l^k - t'_n)\Big). \end{aligned}$$

Therefore,

$$\Pi_{t_n} < 0 \quad \iff \quad \sum_{k=1}^{K} \Big(\cos(\bar{t}_r^k - t'_n) - \cos(\bar{t}_l^k - t'_n)\Big) > 0. \tag{A5}$$

Let us first consider the case when $K = 1$, i.e. the readership is connected. We drop the index $k = 1$ in such case and denote the interval $[\bar{t}_l, \bar{t}_r]$. By definition, $\bar{t}_l \leq \bar{t}_r$ and $t_n \in [\bar{t}_l, \bar{t}_r]$. Moreover, $\bar{t}_l \geq -2\pi/N$. To see this, note that, if $\bar{t}_l < -2\pi/N$, we would need $v((x'_n, t'_n)| - 2\pi/N) > v((x^\star, -2\pi/N)| - 2\pi/N)$. However, this is not possible due to Lemma A3 and the fact that $v((x'_n, t'_n)|-2\pi/N) \leq v((x'_n, 0)|-2\pi/N) = v((x'_n, 0)|2\pi/N)$ and $v((x^\star, -2\pi/N)| - 2\pi/N) = v((x^\star, 0)|0)$.

We consider three different cases, according to which values $\bar{t}_l$ and $\bar{t}_r$ take.

1. Suppose $\bar{t}_l \geq 0$. Note that this implies $\bar{t}_l \leq 2\pi/N$. If this was not the case, $t'_n \geq 2\pi/N$, a contradiction. Let us assume by contradiction that $\cos(\bar{t}_r - t'_n) \leq \cos(\bar{t}_l - t'_n)$. This is equivalent to assuming that $v((x'_n, t'_n)|\bar{t}_l) \geq v((x'_n, t'_n)|\bar{t}_r)$. Define $\hat{t} = 2\pi/N + 2\pi/N - \bar{t}_l$. By construction, type $\hat{t}$ is located as far to the right of $2\pi/N$ as t_l is to the left of $2\pi/N$. Because $v((x^\star, 2\pi/N)|t)$ is symmetric

around $2\pi/N$, we have $v(x^\star, 2\pi/N|\bar{t}_l) = v(x^\star, 2\pi/N|\hat{t})$. Since, by assumption, $v((x^\star, 2\pi/N)|\hat{t}) \geq v((x_n', t_n')|\bar{t}_r)$, it must be that $v((x_n', t_n')|\hat{t}) \geq v((x^\star, 2\pi/N)|\hat{t})$. Therefore, we have:

$$v((x_n', t_n')|\bar{t}_l) \leq v((x_n', t_n')|\hat{t}) \quad \Rightarrow \quad \cos(\bar{t}_l - t_n') \leq \cos(\hat{t} - t_n'),$$

Note that $\bar{t}_l - t_n' \leq 0$ and $\hat{t} - t_n' \geq 0$. Thus, $\bar{t}_l - t_n' \leq -\hat{t} + t_n'$, or

$$t_n \geq \frac{\hat{t} + t_l}{2} = \frac{2\pi/N + 2\pi/N - t_l + t_l}{2} = 2\pi/N,$$

which contradicts our initial assumption that $t_n < 2\pi/N$.

2. We now suppose that $\bar{t}_l \leq 0$ and $\bar{t}_r \leq 2\pi/N$. This necessarily implies that $v((x^\star, 2\pi/N)|\bar{t}_r) = v((x_n', t_n')|\bar{t}_r)$ and $v((x^\star, -2\pi/N)|\bar{t}_l) = v((x_n', t_n')|\bar{t}_l)$. As before, let us assume by contradiction that $\cos(\bar{t}_r - t_n') \leq \cos(\bar{t}_l - t_n')$. This is equivalent to assuming that $v((x_n', t_n')|\bar{t}_l) \geq v((x_n', t_n')|\bar{t}_r)$. Since $v((x_n', t_n')|t)$ is symmetric in t relative to t_n', this means that $t_n' \leq \frac{1}{2}(\bar{t}_r + \bar{t}_l)$. By assumption, we also have that $v((x^\star, -2\pi/N)|\bar{t}_l) \geq v((x^\star, 2\pi/N)|\bar{t}_r)$, which implies $\cos(\bar{t}_l + 2\pi/N) \geq \cos(\bar{t}_r - 2\pi/N)$, which requires $|\bar{t}_l + 2\pi/N| < |\bar{t}_r - 2\pi/N|$. By assumption, $\bar{t}_l + 2\pi/N \geq 0$ and $\bar{t}_r - 2\pi/N < 0$. Therefore, we have that $-\bar{t}_l - 2\pi/N \geq \bar{t}_r - 2\pi/N$, hence $\bar{t}_r + \bar{t}_l \leq 0$. Since $t_n' \leq \frac{1}{2}(\bar{t}_r + \bar{t}_l)$, we have $t_n' \leq 0$, a contradiction.

3. Finally, suppose that $\bar{t}_l \leq 0$ and $\bar{t}_r \geq 2\pi/N$. As before, suppose by contradiction that $v((x_n', t_n')|\bar{t}_l) \geq v((x_n', t_n')|\bar{t}_r)$. This implies that $v((x^\star, -2\pi/N)|\bar{t}_l) \geq v((x^\star, 2\pi/N)|\bar{t}_r)$. This holds irrespective of whether $v((x^\star, 2\pi/N)|\bar{t}_r) = v((x_n', t_n')|\bar{t}_r)$ or $v((x^\star, 2\pi/N)|\bar{t}_r) < v((x_n', t_n')|\bar{t}_r)$. Therefore, $\cos(\bar{t}_l + 2\pi/N) \geq \cos(\bar{t}_r - 2\pi/N)$. By assumption, $\bar{t}_l + 2\pi/N \geq 0$ and $\bar{t}_r - 2\pi/N \geq 0$. Therefore, $\bar{t}_l + 2\pi/N \leq \bar{t}_r - 2\pi/N$ and, hence, $\bar{t}_r - \bar{t}_l \geq 4\pi/N$. Moreover, note that $v((x_n', t_n')|\bar{t}_r)$ is bounded below by $v((x^\star, 2\pi/N)|3\pi/N)$ or, equivalently, by $v((x^\star, 0)|\pi/N)$. A necessary condition for $\bar{t}_r - \bar{t}_l \geq 4\pi/N$ and $v((x_n', t_n')|\bar{t}_r) \geq v((x^\star, 0)|\pi/N)$ to be jointly true is that there exists a $x_n' \in [1/2, 1]$ such that $v((x_n', 0)|2\pi/N) \geq v((x^\star, 0)|\pi/N)$. By Lemma A3, this is not possible, hence we have a contradiction.

Therefore, we showed that, when $K = 1$, $\Pi_{t_n} < 0$. Hence, the arbitrary deviation (x_n', t_n') can not be a profitable one.

To conclude the proof, we analyze the case $K > 1$. In this case, deviation (x_n', t_n') generates a readership with K disconnected intervals. Note that $K > 1$ is possible only if $N > 2$. Therefore, let $N \geq 3$ for the remainder of the proof. Consider an arbitrary deviation (x_n', t_n') with $t_n' \in (0, 2\pi/N)$. We begin by noting that firm n cannot win over type $t = -3\pi/N$. That is,

$$v((x_n', t_n')| - 3\pi/N) \leq v((x_n', 0)| - 3\pi/N) \leq v((x^\star, -2\pi/N)| - 3\pi/N).$$

This is equivalent to showing that, for all $x_n' \in [1/2, 1]$, $v((x_n', 0)|3\pi/N) \leq v((x^\star, 0)|\pi/N)$, which immediately follows from Lemma A3. Next, we show that firm n cannot win over type $t = 5\pi/N$ either (this type exists only if $N \geq 5$. That is,

$$v((x_n', t_n)|5\pi/N) \leq v((x_n', 2\pi/N)|5\pi/N) \leq v((x^\star, 4\pi/N)|5\pi/N)$$

This is equivalent to showing that, for all $x_n' \in [1/2, 1]$, $v((x_n', 0)|3\pi/N) \leq v((x^\star, 0)|\pi/N)$. Again, this immediately follows from Lemma A3. This means that the only possible multi-interval case to consider is the one where $K = 2$. In such case, there are exactly two intervals, which we shall denote $[\bar{t}_l^1, \bar{t}_r^1]$ and $[\bar{t}_l^2, \bar{t}_r^2]$. Moreover, it is easy to see that, in this case, $\bar{t}_l^1 \leq 0$ and $\bar{t}_r^1 \in [0, 2\pi/N]$ and that $\bar{t}_l^2 \geq 2\pi/N$ and $\bar{t}_r^2 \geq 3\pi/N$. By equation A5, we need to show that:

$$\cos(\bar{t}_r^1 - t_n') - \cos(\bar{t}_l^1 - t_n') + \cos(\bar{t}_r^2 - t_n') - \cos(\bar{t}_l^2 - t_n') > 0.$$

We first show that $\cos(\bar{t}_r^2 - t_n') \geq \cos(\bar{t}_l^1 - t_n')$. Suppose not. Then, $v((x_n', t_n')|\bar{t}_l^1) > v((x_n', t_n')|\bar{t}_r^2)$. Note that $v((x_n', t_n')|\bar{t}_r^2)$ is bounded below by $v((x^\star, 2\pi/N)|3\pi/N) = v((x^\star, 0)|\pi/N)$. This implies that $\bar{t}_r^2 - \bar{t}_l^1 > 4\pi/N$. This is possible only if there exists a x_n' such that $v((x_n', 0)|2\pi/N) > v((x^\star, 0)|\pi/N)$. However, Lemma A3 shows that this is not possible and, therefore, we must have $\cos(\bar{t}_r^2 - t_n') \geq \cos(\bar{t}_l^1 - t_n')$.

We now show that $\cos(\bar{t}_r^1 - t_n') - \cos(\bar{t}_l^2 - t_n') > 0$. There are two cases to consider. If $t_n \leq \bar{t}_r^1$, then $\bar{t}_r^1 - t_n' < \bar{t}_l^2 - t_n'$ which immediately implies $\cos(\bar{t}_r^1 - t_n') - \cos(\bar{t}_l^2 - t_n') > 0$. Therefore, suppose instead that $t_n' > \bar{t}_r^1$. Recall that, by definition of $\bar{t}_r^1$, $v((x_n', t_n')|\bar{t}_r^1) = v((x^\star, 2\pi/N)|\bar{t}_r^1)$. Define $\hat{t} = t_n' + (t_n' - \bar{t}_r^1)$ and $\tilde{t} = 2\pi/N + (2\pi/N - \bar{t}_r^1)$. Since $t_n' < 2\pi/N$, we have $\tilde{t} > \hat{t}$. By the symmetry of the value function, $v((x_n', t_n')|\bar{t}_r^1) = v((x_n', t_n')|\hat{t})$ and $v((x^\star, 2\pi/N)|\bar{t}_r^1) = v((x^\star, 2\pi/N)|\tilde{t})$. Therefore, since $\tilde{t} > \hat{t}$, $v((x^\star, 2\pi/N)|\hat{t}) > v((x^\star, 2\pi/N)|\tilde{t}) = v((x_n', t_n')|\hat{t})$. This implies that $\hat{t} < \bar{t}_l^2$, hence $v((x_n', t_n')|\bar{t}_r^1) > v((x_n', t_n')|\bar{t}_l^2)$. We conclude that $\cos(\bar{t}_r^1 - t_n') > \cos(\bar{t}_l^2 - t_n')$. □

A.1.3. Proof of Theorem 2

Lemma A4. *The function* $G(\delta) = \dfrac{2\delta + \sin(2\delta)}{2\sqrt{\delta^2 + \sin^2(\delta)}}$ *is strictly decreasing in* $\delta \in (0, \pi/2)$.

Proof. Note that

$$G'(\delta) = \frac{2 + 2\cos(2\delta)}{2\sqrt{\delta^2 + \sin^2(\delta)}} - \frac{(2\delta + \sin(2\delta))(2\delta + 2\sin(\delta)\cos(\delta))}{4(\delta^2 + \sin^2(\delta))^{3/2}}$$

We want to show that $G'(\delta) < 0$ for $\delta \in (0, \pi/2)$. Multiplying both sides by $(\delta^2 + \sin^2(\delta))^{3/2}$ and using $\sin(2\delta) = 2\sin(\delta)\cos(\delta)$, we get that the sign of $G'(\delta)$ is equal to the sign of

$$\begin{aligned}
& (1 + \cos(2\delta))(\delta^2 + \sin^2(\delta)) - (\delta + \sin(\delta)\cos(\delta))^2 \\
= \; & \delta^2 + \sin^2(\delta) + \cos(2\delta)\delta^2 + \cos(2\delta)\sin^2(\delta) - \delta^2 - 2\delta\sin(\delta)\cos(\delta) - \sin^2(\delta)\cos^2(\delta) \\
= \; & \sin^2(\delta) + \cos(2\delta)\delta^2 + \cos(2\delta)\sin^2(\delta) - \delta\sin(2\delta) - \sin^2(\delta)\cos^2(\delta) \\
= \; & \sin^2(\delta) + \cos(2\delta)\delta^2 - \sin^4(\delta) - \delta\sin(2\delta) \\
< \; & \sin^2(\delta) + \cos(2\delta)\delta^2 - \delta\sin(2\delta) \\
= \; & H(\delta)
\end{aligned}$$

where we used the identity $\cos(2\delta)\sin^2(\delta) = \sin^2(\delta)\cos^2(\delta) - \sin^4(\delta)$ for the second-to-last equality and the fact that $\sin^4(\delta) > 0$ for $\delta \in (0, \pi/2)$ for the last inequality. Note that $H(0) = 0$ and, for all $\delta \in (0, \pi/2)$,

$$\begin{aligned} H'(\delta) &= 2\sin(\delta)\cos(\delta) - 2\sin(2\delta)\delta^2 + \cos(2\delta)2\delta - 2\delta\cos(2\delta) - \sin(2\delta) \\ &= \sin(2\delta) - 2\sin(2\delta)\delta^2 - \sin(2\delta) \\ &= -2\sin(2\delta)\delta^2 \\ &< 0 \end{aligned}$$

Therefore, $H(\delta) < 0$ and, hence, $G'(\delta) < 0$ for all $\delta \in (0, \pi/2)$. □

Lemma A5. *For all $t_2 \in [-\pi, \pi]$ and $x_1 \leq x_2$, the set $\{t \in [-\pi, \pi] | v((x_1, t_1 = 0)|t) \geq v((x_2, t_2)|t)\}$ is an interval in $[-\pi, \pi]$.*

Proof. Let $\Gamma(t) = v((x_1, 0)|t) - v((x_2, t_2)|t)$. If $x_1 = x_2$ and $t_1 = t_2$, $\{\Gamma(t) \geq 0\} = [-\pi, \pi]$ and the claim follows. If $x_1 < x_2$ and $t_1 = t_2$, instead, we have that

$$\{\Gamma(t) \geq 0\} = \{t : \cos(t) \geq \frac{\sqrt{x_2} - \sqrt{x_1}}{\sqrt{1 - x_1} - \sqrt{1 - x_2}} > 0\}.$$

It is immediate to see this is an interval in $[-\pi, \pi]$. Therefore, let $t_2 \neq t_1 = 0$ and $1/2 \leq x_1 \leq x_2$. Suppose $t_2 > 0$. It is immediate to see that $\Gamma(0) > 0$ and $\Gamma(\pi) = \Gamma(-\pi) < 0$. Consider the interval $[0, \pi]$. By continuity of $\Gamma(t)$, there exists at least one $\bar{t} \in (0, \pi)$ such that $\Gamma(\bar{t}) = 0$. We want to show that there is only one such $\bar{t}$. Note that, if $t \in (0, \pi/2]$,

$$\Gamma'(t) = -\sqrt{1 - x_1}\sin(t) + \sqrt{1 - x_2}\sin(t - t_2) < 0.$$

Indeed, $\sqrt{1 - x_1} \geq \sqrt{1 - x_2}$ and $\sin(t) > \sin(t - t_2)$ if $t \in (0, \pi/2]$ (note that while $\sin(t)$ is necessarily positive, $\sin(t - t_2)$ is either negative or positive but smaller than $\sin(t)$). For a similar argument, note that, if $t \in [\pi/2, \pi)$,

$$\Gamma''(t) = -\sqrt{1 - x_1}\cos(t) + \sqrt{1 - x_2}\cos(t - t_2) > 0.$$

Therefore, $\Gamma'(t)$ is strictly increasing in $[\pi/2, \pi)$ and, hence, it is single-crossing. Since $\Gamma(\pi) < 0$, this implies that $\bar{t}$ is the unique type in $[0, \pi]$ such that $\Gamma(\bar{t}) = 0$.

We now apply a parallel argument for the interval $[-\pi, 0]$. By continuity, there exists at least one $\underline{t} \in (-\pi, 0)$ such that $\Gamma(\underline{t}) = 0$. We need to establish its uniqueness. Note that, if $t \in (-\pi, -\pi/2]$, $\Gamma'(t) > 0$. Similarly, if $t \in [-\pi/2, 0)$, $\Gamma''(t) < 0$. Following the argument made above, we can conclude that there exists a unique $\underline{t} \in [-\pi, 0]$ such that $\Gamma(\underline{t}) = 0$.

Therefore, since $\Gamma(0) > 0$, we have that $\{\Gamma(t) \geq 0\} = [\underline{t}, \bar{t}]$. We omit the discussion of the case $t_2 < 0$ as follows trivially from the argument above. □

Lemma A6. *Let $(x_n, t_n)_{n=1}^N$ be a pure-strategy equilibrium. For all n, readership R_n is an interval on the circle.*

Proof. If $N = 1$ there is nothing to prove. Let $N > 1$ and $(x_n, t_n)_{n=1}^N$ be a pure-strategy equilibrium. Without loss of generality, let the firms' labels be such that $x_1 \leq x_2 \leq \ldots \leq x_N$. We divide the proof in three steps. In the first step we establish that R_1 must be an interval on the circle. In the second step, we let $N \geq 2$ and assume that $x_N < 1$. We establish that, if all R_m are intervals on the circle for $m < n$, then R_n is an interval on the circle as well. In the final step, we prove that, when $N \geq 2$, for $(x_n, t_n)_{n=1}^N$ to be an equilibrium, it must be that $x_N < 1$.

Step 1. We establish that firm 1's readership R_1 is an interval on the circle. Without loss of generality, let us normalize locations in $(x_n, t_n)_{n=1}^N$ such that $t_1 = 0$. By definition of readership, $R_1 = \{t \in [-\pi, \pi] | v((x_1, t_1 = 0)|t) \geq V((x_n, t_n)_{n \neq 1}|t)\}$. For each n, define $R_{1,n} = \{t \in [-\pi, \pi] | v((x_1, t_1 = 0)|t) \geq v((x_n, t_n)|t)\}$ and note that $R_1 = \cap_{n \neq 1} R_{1,n}$. Fix an arbitrary $n \neq 1$. Since $x_1 \leq x_n$, the set $R_{1,n}$ is an interval by Lemma A5. Therefore, R_1 is the intersection of finitely many intervals in $[-\pi, \pi]$. Hence, it is an interval.

Step 2. Fix $1 < n \leq N$ and suppose that for all firms $m < n$, R_m is an interval on the circle. Note that, when $N = 2$, firm 1's readership being an interval on the circle implies that firm 2's readership, the complement of R_1, is an interval on the circle as well. Therefore, let $N \geq 3$. In the proof of this step, we will assume $x_N < 1$, a result that we will establish in the next and final step.

By way of contradiction, suppose that firm n's readership R_n is the union of at least two disconnected intervals on the circle denoted $[\underline{a}, \bar{a}]$ and $[\underline{b}, \bar{b}]$. Without loss of generality, let us normalize locations in $(x_n, t_n)_{n=1}^N$ such that $t_n = 0$. Moreover, it is without loss to take $\bar{a} < \underline{b}$ such that $R_n \cap (\bar{a}, \underline{b}) = \emptyset$. Note that it must be that $\underline{a} \geq -\pi$ and $\bar{b} \leq \pi$, with at least one inequality strict. If this was not the case, that is, if both $\underline{a} = -\pi$ and $\bar{b} = \pi$, $[\underline{a}, \bar{a}] \cup [\underline{b}, \bar{b}]$ would represent a single interval on the circle $[-\pi, \pi]$, a contradiction. Since $x_n \leq x_{n'}$ for all $n' \geq n$, Lemma A5 implies that $\bar{R} = \cap_{n' \geq n} R_{n,n'}$ is an interval. Moreover, $[\underline{a}, \bar{a}] \cup [\underline{b}, \bar{b}] \subseteq \bar{R}$. Therefore, types in $(\bar{a}, \underline{b})$ belong to the readership of firms in $M \subseteq \{1, \ldots, n-1\}$. By the inductive assumption, $\{R_m\}_{m \in M}$ are non-overlapping intervals.[17]

Suppose $M = \{m\}$ is a singleton and, therefore, $R_m = [\bar{a}, \underline{b}]$. There are three cases to consider, depending on the location of $\bar{a}$ and $\underline{b}$ relative to $t_n = 0$.

- Suppose that $\underline{b} \leq t_n = 0$. Since $x_n \leq x_N < 1$, $v((x_n, t_n)|t)$ is strictly increasing for all $-\pi < t < t_n$. Therefore, $v((x_m, t_m)|\bar{a}) = v((x_n, t_n)|\bar{a}) < v((x_n, t_n)|\underline{b}) = v((x_m, t_m)|\underline{b})$, where the equalities follow from the definition of threshold types. However, by equation (A5), $v((x_m, t_m)|\bar{a}) < v((x_m, t_m)|\underline{b})$ implies that $\Pi_{t_m} < 0$. Therefore, firm m has a profitable deviation in t_m. A contradiction.
- Suppose, instead, that $\bar{a} \geq t_n = 0$. Since $x_n \leq x_N < 1$, $v((x_n, t_n)|t)$ is strictly decreasing for all $t_n < t < \pi$. Therefore, $v((x_m, t_m)|\bar{a}) = v((x_n, t_n)|\bar{a}) > v((x_n, t_n)|\underline{b}) = v((x_m, t_m)|\underline{b})$. Therefore, by

[17]Whether two intervals R_m and $R_{m'}$ overlap at an end point is a matter of convention. This has not bearing on firms' behavior because a threshold type—namely the type who is at the boundary of a readership interval—yields a profit of 0 to the firm from which she acquires information.

equation (A5), $\Pi_{t_m} > 0$. Hence, firm m has a profitable deviation. A contradiction.

– Finally, suppose that $\bar{a} < 0 < \underline{b}$. Equilibrium requires that $v((x_m, t_m)|\bar{a}) = v((x_n, t_n)|\bar{a}) = v((x_n, t_n)|\underline{b}) = v((x_m, t_m)|\underline{b})$. This implies that $t_m = t_n = 0$. While $\Pi_{t_m} = 0$, profits for firm m are at a local minimum. Suppose firm m deviates to $t'_m = t_m + dt_m$. Such deviation would strictly increase $v((x_m, t'_m)|\bar{a})$ (since $v((x_n, t_n)|t)$ is strictly increasing at $t = \bar{a}$) and strictly decreases $v((x_m, t'_m)|\underline{b})$ (since $v((x_n, t_n)|t)$ is decreasing at $t = \underline{b}$). Therefore, by equation (A5), this implies $\Pi_{t_m} > 0$. Hence, firm m has a profitable deviation. A contradiction.

Suppose M is not a singleton. Denote by m_A and m_B the two firms whose readerships are at opposite extremes of the interval $(\bar{a}, \underline{b})$. Since $m_A, m_B \in M$, R_{m_A} and R_{m_B} are disjoint intervals in $(\bar{a}, \underline{b})$. Therefore, there must be $\bar{a}' \leq \underline{b}'$ such that $R_{m_a} = [\bar{a}, \bar{a}']$ and $R_{m_b} = [\underline{b}', \underline{b}]$. There are two cases to consider, depending on the location of $\bar{a}'$ relative to $t_n = 0$.

– Suppose $\bar{a}' \leq t_n = 0$. Since $x_n \leq x_N < 1$, $v((x_n, t_n)|t)$ is strictly increasing for all $-\pi < t < t_n$. Therefore, $v((x_{m_A}, t_{m_A})|\bar{a}) = v((x_n, t_n)|\bar{a}) < v((x_n, t_n)|\bar{a}') \leq v((x_{m_A}, t_{m_A})|\bar{a}')$. The last inequality comes about because if firm m_A does not share type $\bar{a}'$ with firm n, it must be sharing $\bar{a}'$ with some firm in M yielding a value higher than $v((x_n, t_n)|\bar{a}')$. However, by equation (A5), $v((x_{m_A}, t_{m_A})|\bar{a}) < v((x_{m_A}, t_{m_A})|\bar{a}')$ implies that $\Pi_{t_{m_A}} < 0$. Therefore, firm m_A has a profitable deviation. A contradiction.

– Conversely, suppose that $\bar{a}' > t_n = 0$. Therefore, $\underline{b}' \geq \bar{a}' > 0$. Since $x_n \leq x_N < 1$, $v((x_n, t_n)|t)$ is strictly decreasing for all $t_n < t < \pi$. Therefore, $v((x_{m_B}, t_{m_B})|\underline{b}') \geq v((x_n, t_n)|\underline{b}') > v((x_n, t_n)|\underline{b}) = v((x_{m_B}, t_{m_B})|\underline{b})$. The first inequality comes about because if firm m_B does not share type $\underline{b}'$ with firm n, it must be sharing $\underline{b}'$ with some firm in M yielding a value higher than $v((x_n, t_n)|\underline{b}')$. However, by equation (A5), $v((x_{m_B}, t_{m_B})|\underline{b}) < v((x_{m_B}, t_{m_B})|\underline{b}')$ implies that $\Pi_{t_{m_A}} > 0$. Therefore, firm m_A has a profitable deviation. A contradiction.

Therefore, R_n must be an interval, which concludes the inductive step. By induction, R_n is an interval for all $1 \leq n \leq N$.

Step 3. We are left to establish that $x_N < 1$ and, a fortiori, $x_n < 1$ for all $n \leq N$.[18] To see this, suppose not, i.e. $x_N = 1$. By the inductive assumption $R_n = [\underline{t}_n, \bar{t}_n]$ is an interval on the circle for all $n < N$. Since $x_N = 1$, $v((x_n, t_n)|\bar{t}_n) = 1$ for all n. For $n < N$, denote $\delta_n = \bar{t}_n - t_n$. Equation (A5) requires that $t_n - \underline{t}_n = \delta_n$, as well. Therefore, $\delta_n > 0$, otherwise firm n would make zero profits. Using equation (A4), the value generated for the threshold type with distance to δ_n to the target, $G(\delta_n)$, must satisfy

$$G(\delta_n) = \frac{2\delta_n + \sin(2\delta_n)}{2\sqrt{\delta_n^2 + \sin^2(\delta_n)}} = 1.$$

[18]Note that, if $x_n = 1$ and $n < N$, at least two firms, n and N, have $x_n = x_N = 1$. Therefore, they make zero profits, an immediate contradiction

Note that $\lim_{\delta_n \to 0^+} G(\delta_n) = \sqrt{2} > 1$ and $G(\pi/2) < 1$. Moreover, by Lemma A4, $G(\delta_n)$ strictly decreasing for all $\delta_n \in (0, \pi/2)$. Therefore, $G(\delta_n) = 1$ admits at most one solution in such interval. It is easy to verify that $\delta = \frac{\pi}{2} - \frac{\sqrt{3}}{5}$ is such solution, which is independent of n. That is, all firms $n < N$ have a readership of 2δ. If $N > 3$, $(N-1)2\delta > 2\pi$, hence firm N would make zero profits, a contradiction since $(x_n, t_n)_{n=1}^N$ is an equilibrium. Thus, the only non-trivial case to consider is $N = 3$. Without loss of generality, let $t_1 < t_2$ and $t_3 = \frac{1}{2}(t_1 + t_2) = 0$. Thus, $t_2 = -t_1$. Moreover, we can let $t_2 \geq \pi/2$ (if this was not the case, firm 3 could deviate to $t_3' = \pi$ and the argument that follows would hold). Finally, since $t_2 + \delta \leq \pi$, let $t_2 \leq \pi - \delta = \pi/2 + \sqrt{3}/5$. Therefore, $t_2 \in [\pi/2, \pi/2 + \sqrt{3}/5]$. Now consider a deviation x_3' that is arbitrarily close to 1. If $(x_n, t_n)_{n=1}^N$ is indeed an equilibrium, such deviation should be weakly unprofitable. We will show instead it is strictly profitable. Let $R_2 = [\underline{t}, \bar{t}]$ the new readership for firm 2 that such deviation induces. By symmetry, $R_1 = [-\bar{t}, -\underline{t}]$. Consider the derivative with respect to x_3 of firm 3's profit function evaluated at x_3'. Equation (A3) gives

$$\Pi_{x_3}\Big|_{x_3'} = \frac{1}{2\pi}\left(\frac{1}{2\sqrt{x_3'}}(2\underline{t} + 2(\pi - \bar{t})) - \frac{1}{2\sqrt{1 - x_3'}}\Big(2\sin(\underline{t}) - 2\sin(\bar{t})\Big)\right).$$

The first term is bounded above by $\sqrt{2}\pi$. The second term grows unboundedly to either plus or minus infinity, as x_3' is closer to 1. Its sign is equal to the sign of $\sin(\bar{t}) - \sin(\underline{t})$. Note that $t_2 \geq \pi/2$ by assumption, and $\bar{t} = t_2 + \delta$ and $\underline{t} = t_2 - \delta$ with both $\underline{t}, \bar{t} \in [0, \pi]$. Therefore, $\sin(\bar{t}) - \sin(\underline{t}) < 0$ implying that that the derivative Π_{x_3} is strictly negative when evaluated at a x_3' that is sufficiently close to 1. Therefore, a small deviation that marginally decreases $x_3 = 1$ would be profitable for the firm. □

Proof of Theorem 2. Let $N \geq 1$ and consider an arbitrary pure-strategy equilibrium $(x_n, t_n)_{n=1}^N$. By Lemma A6, the readership of firm n is an interval R_n on the circle. By equation (A5), this implies that each firm is located at the midpoint of its readership interval, i.e. $R_n = [t_n - \delta_n, t_n + \delta_n]$ for some $\delta_n > 0$. Moreover, it implies that firm n sets $x_n = x^\star(\delta_n)$, the only value of x_n that solves equation (A4), given $\bar{t}_{n,r} = \delta_n$ and $\bar{t}_{n,l} = -\delta_n$. We want to show that $\delta_n = \delta = \pi/N$ for all n and, thus, $x_n = x^\star$. That is, $(x_n, t_n)_{n=1}^N$ is the equilibrium characterized by Theorem 1.

Suppose that, in this equilibrium, there are two firms, 1 and 2, such that $\delta_1 > \delta_2$. Without loss of generality, let $0 = t_1 < t_2$ and suppose these firms are adjacent. That is, type $\bar{t} = t_1 + \delta_1 = t_2 - \delta_2$ is their threshold type. This implies that $v((x_1, t_1)|\bar{t}) = v((x_2, t_2)|\bar{t})$. Since $\bar{t} - t_n = \delta_n$ and $x_n = x^\star(\delta_n)$ can be expressed in terms of δ_n only, we can write $v((x_n, t_n)|\bar{t})$ as a function of δ_n:

$$v((x_1, t_1)|\bar{t}) = \frac{2\delta_1 + \sin(2\delta_1)}{2\sqrt{\delta_1^2 + \sin^2(\delta_1)}} \quad \text{and} \quad v((x_2, t_2)|\bar{t}) = \frac{2\delta_2 + \sin(2\delta_2)}{2\sqrt{\delta_2^2 + \sin^2(\delta_2)}}.$$

Suppose $\delta_1 \leq \pi/2$ and, a fortiori, $\delta_2 \leq \pi/2$. Lemma A4 shows that this function is strictly decreasing in the interval $(0, \pi/2)$. Therefore $v((x_1, t_1)|\bar{t}) = v((x_2, t_2)|\bar{t})$ if and only if $\delta_1 = \delta_2$, a contradiction.

Suppose instead $\delta_1 > \pi/2$. Since the size of the market is 2π, $\delta_2 \leq \frac{2\pi - 2\delta_1}{2} = \pi - \delta_1 < \pi/2$. We will show that, in this case, $v((x_1, t_1)|\bar{t}) < v((x_2, t_2)|\bar{t})$, a contradiction. Note that,

$$v((x_2, t_2)|\bar{t}) = \frac{2\delta_2 + \sin(2\delta_2)}{2\sqrt{\delta_2^2 + \sin^2(\delta_2)}} \geq \frac{2(\pi - \delta_1) + \sin(2(\pi - \delta_1))}{2\sqrt{(\pi - \delta_1)^2 + \sin^2(\pi - \delta_1)}},$$

since $0 < \delta_2 \leq \pi - \delta_1 < \pi/2$ and Lemma A4. Put $y = \pi - \delta_1$ and $\delta_1 = \pi - y$. Thus, we need to show that

$$\frac{2y + \sin(2y)}{2\sqrt{y^2 + \sin^2(y)}} > \frac{2(\pi - y) + \sin(2(\pi - y))}{2\sqrt{(\pi - y)^2 + \sin^2(\pi - y)}}$$

Use $\sin(2(\pi - y)) = -\sin(2y)$ and $\sin^2(\pi - y) = \sin^2(y)$ and simplify to obtain

$$\frac{(2y + \sin(2y))^2}{y^2 + \sin^2(y)} > \frac{(2(\pi - y) - \sin(2y))^2}{(\pi - y)^2 + \sin^2(y)}$$

or, equivalently,

$$(2y + \sin(2y))^2((\pi - y)^2 + \sin^2(y)) > (2(\pi - y) - \sin(2y))^2(y^2 + \sin^2(y))$$

Simplifying, we obtain,

$$\begin{aligned} 4y^2 \sin^2(y) + 4y\sin(2y)(\pi - y)^2 + 4y\sin(2y)\sin^2(y) + \sin^2(2y)(\pi - y)^2 \quad > \\ 4(\pi - y)^2 \sin^2(y) - 4(\pi - y)\sin(2y)(y)^2 - 4(\pi - y)\sin(2y)\sin^2(y) + \sin^2(2y)y^2 \end{aligned}$$

Looking at the last term on both sides, note that $\sin^2(2y)(\pi - y)^2 > \sin^2(2y)y^2$, since $y \in (0, \pi/2)$. Looking at the second-to-last term on both sides, note that $4y\sin(2y)\sin^2(y) > -4(\pi - y)\sin(2y)\sin^2(y)$. Therefore, it is enough to show that, in the interval $y \in (0, \pi/2)$

$$G(y) = y^2 \sin^2(y) + y\sin(2y)(\pi - y)^2 - (\pi - y)^2 \sin^2(y) + (\pi - y)\sin(2y)y^2 > 0.$$

Note that $G(0) = 0$ and $G(\pi/2) = 0$. Moreover, if $y \in (0, \pi/4)$

$$G'(y) = \sin^2(y)2\pi + 2\cos(2y)(y(\pi - y)^2 + (\pi - y)y^2) > 0.$$

Therefore, $G(y)$ is strictly positive for all $y \in (0, \pi/4)$. Moreover, if $y \in (\pi/4, \pi/2)$,

$$G''(y) = \sin(2y)2\pi + 2\cos(2y)((\pi - y)^2 - y^2) - 4\sin(2y)(y(\pi - y)^2 + (\pi - y)y^2) < 0.$$

This implies that, when $G'(y)$ turns negative, it remains negative. Since $G(\pi/2) = 0$, this implies that $G(y)$ cannot cross zero before $\pi/2$.

Therefore, $G(y) > 0$ for all $y \in (0, \pi/2)$. This implies that $v((x_1, t_1)|\bar{t}) < v((x_2, t_2)|\bar{t})$, a contradiction. □

A.2. Proofs for Section 4

Proof of Proposition 1. Let $(x_n^\star, t_n^\star)_{n=1}^N$ be an equilibirum with N firms. From equation A4 in the proof of Theorem 1, we have that $x_n^\star = x^\star$ satisfies

$$\sqrt{\frac{1-x^\star}{x^\star}} = \frac{\sin(\pi/N)}{\pi/N}.$$

This implies a one-to-one relationship between $x^\star$ and N, which we denote by $x^\star(N)$. With a change of variable $\delta = \pi/N$, let

$$x^\star(\delta) = \frac{\delta^2}{\delta^2 + \sin^2(\delta)}. \tag{A6}$$

It is enough to show that $x^\star(\delta)$ is strictly increasing in δ, for all $\delta \in (0, \pi)$. Note that

$$\frac{d}{d\delta} x^\star(\delta) = \frac{2\delta(\delta^2 + \sin^2(\delta)) - \delta^2(2\delta + 2\sin(\delta)\cos(\delta))}{(\delta^2 + \sin^2(\delta))^2}.$$

We need to show that, for all $\delta \in (0, \pi)$, $\delta \sin(\delta)(\sin(\delta) - \delta\cos(\delta)) > 0$. Note that, $\delta\sin(\delta) > 0$ for all $\delta \in (0, \pi)$. Therefore, it is enough to show that $G(\delta) = \sin(\delta) - \delta\cos(\delta) > 0$. Since $G(0) = 0$, $G'(\delta) = \cos(\delta) - \cos(\delta) + \delta\sin(\delta) = \delta\sin(\delta) > 0$ for all $\delta \in (0, \pi)$ implies $G(\delta) > 0$. We conclude that $x^\star(\delta)$ is strictly increasing in δ for all $\delta \in (0, \pi)$ or, equivalently, $x^\star(N)$ is strictly decreasing in N for all $N > 1$.□

Proof of Proposition 2.

Part (a). Fix $N \geq 1$. We begin by computing the $\mathcal{V}^\star(N)$ for an arbitrary pure-strategy equilibrium of the game with N firms. Let $(x^\star(N), t_n^\star)_{n=1}^N$ be the equilibrium profile of editorial strategies and $r^\star(t_i) \in \{1, \ldots, N\}$ be the equilibrium information-acquisition strategy for type t_i. Then, $\mathcal{V}^\star(N) = \mathbb{E}_{t_i}(v((x^\star(N), t^\star_{r^\star(t_i)})|t_i)$, where the expectation is taken over t_i, which is uniformly distributed over $T = [-\pi, \pi]$. Since $r^\star(t_i) = n$ only if $t_i \in [t_n^\star - \pi/N, t_n^\star + \pi/N]$. Therefore,

$$\begin{aligned}
\mathcal{V}^\star(N) &= \sum_{n=1}^N \int_{t_n^\star - \frac{\pi}{N}}^{t_n^\star + \frac{\pi}{N}} v(x^\star(N), t_n^\star)|t_i) \frac{1}{2\pi} dt_i \\
&= N \int_{-\frac{\pi}{N}}^{\frac{\pi}{N}} v(x^\star(N), 0)|t_i) \frac{1}{2\pi} dt_i \\
&= \lambda \frac{N}{\pi} \Big(\sqrt{x^\star(N)} \frac{\pi}{N} + \sqrt{1 - x^\star(N)} \sin(\pi/N) \Big)
\end{aligned}$$

The second equality obtains because, thanks to the symmetry in the equilibrium editorial strategies, we can normalize the location of a firm to 0. By substituting in the expression above the equilibrium value of $x^\star(N)$ (see Equation A4), we obtain

$$\begin{aligned}
\mathcal{V}^\star(N) &= \lambda \frac{N}{\pi} \sqrt{(\pi/N)^2 + \sin^2(\pi/N)} \\
&= \frac{\lambda}{\sqrt{x^\star(N)}}.
\end{aligned}$$

The last equality holds by definition of $x^\star(N)$ (Equation A4). We are left to show that $\mathcal{V}^\star(N)$ is strictly increasing in N. This follows from Proposition 1, since $x^\star(N)$ is strictly decreasing in N.

Part (b). Fix $N \geq 1$. We begin by computing $\mathcal{P}(N)$ for an arbitrary pure-strategy equilibrium of the game with N firms. Later, we will show that it is strictly decreasing in N. Let $(x^\star(N), t_n^\star)_{n=1}^N$ be an equilibrium profile of editorial strategies, $(p_n^\star)_{n=1}^N$ be the equilibrium prices, and $r^\star(t_i) \in \{1, \ldots, N\}$ be the equilibrium information-acquisition strategy for a type t_i. We have that $\mathcal{P}(N) = I \cdot \mathbb{E}_{t_i}(p^\star_{r^\star(t_i)}(t_i)|t_i)$. Indeed, $\mathbb{E}_{t_i}(p^\star_{r^\star(t_i)}(t_i)|t_i)$ is the industry profit generated by one of the I agents. In equilibrium, $r^\star(t_i) = n$ only if $t_i \in [t_n^\star - \pi/N, t_n^\star + \pi/N]$. Moreover, if $t_i \in [t_n^\star - \pi/N, t_n^\star + \pi/N]$, $p_n^\star(t_i) = v((x^\star(N), t_n^\star)|t_i) - \max\{v((x^\star(N), t_m^\star)|t_i)|m \neq n\}$. If $N = 1$, it is immediate to see that $\mathcal{P}(1) = I \int_{-\pi}^{\pi} v((1,0)|t_i)\frac{1}{2\pi}dt_i = \frac{1}{2\sqrt{\pi}}$. If $N > 1$, we can write:

$$\begin{aligned}
\mathcal{P}(N) &= 2I \sum_{n=1}^{N} \int_{t_n^\star}^{t_n^\star + \frac{\pi}{N}} p_n^\star(t_i)\frac{1}{2\pi}dt_i \\
&= \frac{2IN}{2\pi}\int_0^{\frac{\pi}{N}} v(x^\star(N), 0)|t_i) - v(x^\star(N), 2\pi/N)|t_i)dt_i \\
&= \frac{1}{2\sqrt{\pi}}\sqrt{1 - x^\star(N)}\frac{2\sin(\frac{\pi}{N}) - \sin(\frac{2\pi}{N})}{\pi/N} \\
&= \frac{1}{\sqrt{\pi}}\frac{1 - x^\star(N)}{\sqrt{x^\star(N)}}\Big(1 - \cos(\pi/N)\Big).
\end{aligned}$$

The last equality obtains by using Equation (A4). We want to show that $\mathcal{P}(N)$ is strictly decreasing in N. With a change of variable, let $\delta = \pi/N \in (0, \pi]$. Using Equation (A6), we can rewrite $\mathcal{P}(N)$ as

$$\mathcal{P}(\delta) = \frac{1}{\sqrt{\pi}}\frac{\sin^2(\delta)}{\delta}\frac{1 - \cos(\delta)}{\sqrt{\delta^2 + \sin^2(\delta)}}.$$

Using the expression above, it is immediate to compute $\mathcal{P}(\frac{\pi}{2})$ and verify that it is strictly smaller than $\mathcal{P}(\pi)$. Similarly, we can directly verify that $\mathcal{P}(\frac{\pi}{4}) < \mathcal{P}(\frac{\pi}{3}) < \mathcal{P}(\frac{\pi}{2})$. We are left to show that $\mathcal{P}(\delta)$ is strictly increasing for all $\delta \in (0, \pi/4]$. Note that $\mathcal{P}(\delta) > 0$ for all $\delta \in (0, \pi/4]$. Therefore, it is enough to show that $(\mathcal{P}(\delta))^2$ is strictly increasing. Dropping the constant and replacing variable δ with x, let

$$G(x) = \frac{\sin^4(x)(1 - \cos(x))^2}{x^2(\sin^2(x) + x^2)}.$$

Since $\lim_{x\to 0} G(x) = 0$, it is enough to show that $G'(x) > 0$ for all $x \in (0, \pi/4]$. The sign of $G'(x)$ is determined by the sign of its numerator, which is:

$$\begin{aligned}
&\Big(4\sin^3(x)\cos(x)(1 - \cos(x))^2 + \sin^5(x)2(1 - \cos(x))\Big)\Big(x^2(\sin^2(x) + x^2)\Big) - \\
&\Big(\sin^4(x)(1 - \cos(x))^2\Big)\Big(2x(\sin^2(x) + x^2) + x^2(2x + 2\sin(x)\cos(x))\Big)
\end{aligned}$$

Dividing everything by $2\sin^3(x)(1 - \cos(x))x$, which is strictly positive for $x \in (0, \pi/4]$, we obtain

$$\begin{aligned}
&\Big(2\cos(x)(1 - \cos(x)) + \sin^2(x)\Big)\Big(x(\sin^2(x) + x^2)\Big) - \\
&(\sin(x)(1 - \cos(x)))\Big(2x^2 + \sin^2(x) + x\sin(x)\cos(x)\Big) \\
= \;&(1 - \cos(x))\,(3\cos(x) + 1))\Big(x(\sin^2(x) + x^2)\Big) - \\
&(\sin(x)(1 - \cos(x)))\Big(2x^2 + \sin^2(x) + x\sin(x)\cos(x)\Big).
\end{aligned}$$

The equality holds since $\sin^2(x) = 1 - \cos^2(x) = (1 - \cos(x))(1 + \cos(x))$. We can further divide the last expression by $1 - \cos(x) > 0$ to obtain:

$$\begin{aligned} & (1 + 3\cos(x))\left(x\sin^2(x) + x^3\right) - \sin(x)\left(2x^2 + \sin^2(x) + x\sin(x)\cos(x)\right) \\ = \;& x\sin^2(x) + 2\cos(x)x\sin^2(x) + (1 + 3\cos(x))\, x^3 - \sin(x)2x^2 - \sin^3(x) \\ > \;& x\sin^2(x) + 2\cos(x)x\sin^2(x) + 3\cos(x)x^3 - \sin(x)2x^2 \\ > \;& 3\cos(x)x^3 - \sin(x)2x^2 \\ > \;& 0 \end{aligned}$$

The first inequality holds because $x > \sin(x)$ if $x \in (0, \pi/4]$. Similarly, the second inequality holds because $x\sin^2(x) \geq 0$ and $2\cos(x)x\sin^2(x) > 0$ in the same range. The last inequality holds because $3\cos(x)x^3 - \sin(x)2x^2 > 0$ if and only if $3\cos(x) - 2\frac{\sin(x)}{x} > 0$. Since $x > \sin(x)$, $3\cos(x) - 2\frac{\sin(x)}{x} > 3\cos(x) - 2 > 0$, which holds true for $\delta \in (0, \pi/4]$. Therefore, $G'(x) > 0$ for all $x \in (0, \pi/4]$. Hence $G(x)$ is strictly increasing in x and, equivalently, $\mathcal{P}(\delta)$ is strictly increasing in $\delta \in (0, \pi/4]$. □

Proof of Remark 2. Fix an arbitrary type t_i. The value of information for type t_i at an arbitrary equilibrium $(x^\star(N), t_n^\star)_{n=1}^N$ is bounded below by $\underline{v}_N = \lambda(\sqrt{x^\star(N)} + \sqrt{1 - x^\star(N)}\cos(\pi/N))$ and it is bounded above by $\hat{v}_N = \lambda(\sqrt{x^\star(N)} + \sqrt{1 - x^\star(N)})$. Equation A4 implies that $\lim_{N\to\infty} x^\star(N) = 1/2$. Therefore, $\lim_{N\to\infty} \underline{v}_N = \lim_{N\to\infty} \hat{v}_N = \lambda\sqrt{2}$. This implies that $v((x^\star(N), t^\star_{r^\star(t_i)})|t_i)$ converges to $\lambda\sqrt{2}$ as $N \to \infty$. Finally, note that $\lambda\sqrt{2}$ is the first-best value of information of an agent of type t_i, namely $\max_{(x_n, t_n)} v((x_n, t_n)|t_i) = \lambda\sqrt{2}$. □

Remark A1. *Fix an arbitrary sequence of equilibria $((x_n^N, t_n^N)_{n=1}^N)_{N\in\mathbb{N}}$ and a type t_i. There exists a subsequence (N_k) such that the equilibrium value of information for agent t_i is strictly increasing in k.*

Proof. Fix $((x_n^N, t_n^N)_{n=1}^N)_{N\in\mathbb{N}}$ and a type t_i. Let $v_{t_i,N}$ be the equilibrium value of information for type t_i when N firms are competing. The proof of Proposition 2 Part (b) shows that the sequence $(v_{t_i,N})_N$ is converging to $\lambda\sqrt{2}$. Therefore, it admits a monotone subsequence. Since $v_{t_i,N} \leq \lambda\sqrt{2}$ for all N, such subsequence must be increasing. □

Proof of Proposition 3. Fix $N \geq 1$ and let $(x^\star(N), t_n^\star)_n^N$ be the equilibrium profile of editorial strategies. Consider two agents t_i and t_j and suppose that, in equilibrium, acquire information from firm n and m, respectively. Denote $s_i = s_i(\omega, (x^\star(N), t_n^\star)$ the signal that agent i receives, $z_i = \mathbb{E}_\omega(u(\omega, t_i)|s_i)$ her expected utility, and $v_i = v((x^\star(N), t_n^\star)|t_i)$. Using Equation A1 and Remark 1, we have that

$$z_i = \frac{v_i}{\lambda}\Big(\sqrt{x^\star(N)}\omega_0 + \sqrt{1 - x^\star(N)}(\omega_1\cos(t_n^\star) + \omega_2\sin(t_n^\star)) + \varepsilon_i\Big) \sim N(0, 2v_i^2/\lambda^2).$$

Therefore, the correlation between z_i and z_j is given by

$$\begin{aligned} \rho_{z_i,z_j} &= \frac{\lambda^2 \mathrm{Cov}(z_i, z_j)}{2v_i v_j} \\ &= \frac{1}{2v_i v_j\lambda^2} v_i v_j \lambda^2\Big(x^\star(N) + (1 - x^\star(N))(\cos(t_n^\star)\cos(t_m^\star)) + \sin(t_n^\star)\sin(t_m^\star))\Big) \\ &= \frac{1}{2}\Big(x^\star(N) + (1 - x^\star(N))\cos(t_n^\star - t_m^\star)\Big) \end{aligned}$$

Next, we let the type t_i of agent i be uniformly drawn from the type space T. In this case, the firm n that agent i chooses is random. However, since in equilibrium firms are spread out evenly, agent i is equally likely to choose any of the N firms. Therefore,

$$\begin{aligned}\mathbb{E}_{t_i,t_j}\rho_{z_i,z_j} &= \frac{1}{2}x^\star(N) + (1 - x^\star(N))\mathbb{E}_{t_j}\mathbb{E}_{t_i}\Big(\cos(t_n^\star - t_m^\star)\Big) \\ &= \frac{1}{2}x^\star(N) + (1 - x^\star(N))\frac{1}{2N^2}\sum_{n=1}^{N}\sum_{m=1}^{N}\Big(\cos(t_n^\star - t_m^\star)\Big).\end{aligned}$$

We are going to show that $\sum_{n=1}^N \sum_{m=1}^N \Big(\cos(t_n^\star - t_m^\star)\Big) = 0$. Without loss of generality, we can normalize the location of firm $n = 1$ to be $t_1^\star = 0$. As a consequence, $t_n^\star = \frac{2\pi(n-1)}{N}$, for all n. Therefore, letting $\delta = 2\pi/N$,

$$\begin{aligned}\sum_{n=1}^{N}\sum_{m=1}^{N}\Big(\cos(t_n^\star - t_m^\star)\Big) &= \sum_{n=0}^{N-1}\sum_{m=0}^{N-1}\cos\Big((n-1)\delta - (m-1)\delta\Big) \\ &= \sum_{n=1}^{N}\sum_{m=1}^{N}\cos\Big((n-m)\delta\Big) \\ &= \sum_{n=1}^{N}\sum_{k=n-N}^{n-1}\cos(k\delta) \\ &= \sum_{n=1}^{N}\Big(\sum_{k=n-N}^{0}\cos(k\delta) + \sum_{k=1}^{n-1}\cos(k\delta)\Big)\end{aligned}.$$

The second-to-last equality follows from the substitution $k = n - m$. The lower and upper indexes of the summation are substituted accordingly. The highest possible m is N and leads to the lower index $n - N$. The lowest possible m is 1 and leads to the highest index $n - 1$. The last equality follows from splitting in two the summation $\sum_{k=n-N}^{n-1}\cos(k\delta)$. This separates the terms with $k \leq 0$ and $k > 0$.

Using $N\delta = 2\pi$ and $\cos(y) = \cos(y + 2\pi)$ for all $y \in \mathbb{R}$, we have

$$\sum_{k=n-N}^{0}\cos(k\delta) = \sum_{k=n-N}^{0}\cos(k\delta + N\delta) = \sum_{k=n-N}^{0}\cos((k+N)\delta) = \sum_{k=n}^{N}\cos(k\delta).$$

Thus,

$$\begin{aligned}\sum_{n=1}^{N}\sum_{m=1}^{N}\Big(\cos(t_n^\star - t_m^\star)\Big) &= \sum_{n=1}^{N}\Big(\sum_{k=n-N}^{0}\cos(k\delta) + \sum_{k=1}^{n-1}\cos(k\delta)\Big) \\ &= \sum_{n=1}^{N}\Big(\sum_{k=n}^{N}\cos(k\delta) + \sum_{k=1}^{n-1}\cos(k\delta)\Big) \\ &= \sum_{n=1}^{N}\sum_{k=1}^{N}\cos(k\delta) \\ &= N\sum_{k=1}^{N}\cos(k\delta) \\ &= N\Big(-\frac{1}{2} + \frac{\sin((N+\frac{1}{2}))\frac{2\pi}{N})}{2\sin(\frac{\pi}{N})}\Big) \\ &= N\Big(-\frac{1}{2} + \frac{\sin(\frac{\pi}{N}))}{2\sin(\frac{\pi}{N})}\Big) = 0.\end{aligned}$$

The third-to-last row follows from the Lagrange's trigonometric identity. The last row, instead, uses $\sin(y + 2\pi) = \sin(y)$ for all $y \in \mathbb{R}$.

Therefore, we conclude that $\mathbb{E}_{t_i,t_j}\rho_{z_i,z_j} = \frac{1}{2}x^\star(N)$, which is strictly decreasing in N by Proposition 1.□

Lemma A7. *Fix N and let $(x^\star(N), t_n^\star)_{n=1}^N$ be an equilibrium profile of editorial strategies. For all ω_0,*

$$\bar{a}_i(\omega_0) := \mathbb{E}_{\omega_1,\omega_2,t_i}\Big(a_i((\omega_0,\omega_1,\omega_2),t_i)\Big) = \Phi\Big(\frac{\sqrt{x^\star(N)}}{\sqrt{2-x^\star(N)}}\omega_0\Big).$$

Proof of Lemma A7. Fix N and an equilibrium profile of editorial strategies $(x^\star(N), t_n^\star)_{n=1}^N$. Suppose that, in this equilibrium, agent t_i acquires information from firm n. Conditional on a signal realization $\bar{s} = s(\omega, (x^\star(N), t_n^\star))$, the agent's equilibrium approval strategy is characterized in Lemma 1 and depends on $\mathbb{E}_\omega(u(\omega, t_i)|\bar{s})$. Using Equation A1 and Remark 1, we have that

$$\mathbb{E}_\omega(u(\omega,t_i)|\bar{s}) = \frac{v((x^\star(N),t_n^\star)|t_i)}{\lambda}\Big(\sqrt{x^\star(N)}\omega_0 + \sqrt{1-x^\star(N)}(\omega_1\cos(t_n^\star) + \omega_2\sin(t_n^\star)) + \varepsilon_i\Big).$$

Since, in equilibrium, $\frac{v((x^\star(N),t_n^\star)|t_i)}{\lambda} > 0$, the agent approves if and only if the signal she observes is positive. Since $\varepsilon_i \sim N(0,1)$, the probability that agent t_i approves policy ω before ε_i realizes is given by $\bar{a}_i^\star(\omega, t_i) = \Phi\Big(\sqrt{x^\star(N)}\omega_0 + \sqrt{1-x^\star(N)}(\cos(t_n^\star)\omega_1 + \sin(t_n^\star)\omega_2)\Big)$, where Φ denotes the CDF of the standard normal distribution. Thanks to the symmetry in the equilibrium location (Theorem 2) and the uniformity of the distribution of t_i, we have that

$$\mathbb{E}_{t_i}\Big(a_i(\omega,t_i)\Big) = \frac{1}{N}\sum_n \Phi\Big(\sqrt{x^\star(N)}\omega_0 + \sqrt{1-x^\star(N)}(\cos(t_n^\star)\omega_1 + \sin(t_n^\star)\omega_2)\Big)$$

We need to compute the expectation of the expression above with respect to ω_1 and ω_2. Since ω_1 and ω_2 are independent, we do so in two separate steps. For both steps, we use the identity $\int_{\mathbb{R}} \Phi(\alpha+\gamma y)d\Phi(y) = \Phi(\alpha/\sqrt{1+\gamma^2})$ (see, Patel and Read, 1996). We begin by integrating with respect to ω_2. Let $y = \omega_2$ and, for each n, let $\alpha_n = \sqrt{x^\star}\omega_0 + \sqrt{1-x^\star}\cos(t_n^\star)\omega_1$ and $\gamma_n = \sqrt{1-x^\star}\sin(t_n^\star)$. Using the integral identity, we obtain

$$\mathbb{E}_{\omega_2,t_i}\Big(a_i(\omega,t_i)\Big) = \frac{1}{N}\sum_n \Phi\Big(\frac{\alpha_n}{\sqrt{1+\gamma_n^2}}\Big) = \frac{1}{N}\sum_n \Phi\Big(\frac{\sqrt{x^\star}\omega_0 + \sqrt{1-x^\star}\cos(t_n^\star)\omega_1}{\sqrt{1+(1-x^\star)\sin^2(t_n^\star)}}\Big).$$

Next, we integrate the above with respect to ω_1. Let $y = \omega_1$ and

$$\alpha_n' = \frac{\sqrt{x^\star}\omega_0}{\sqrt{1+(1-x^\star)\sin^2(t_n^\star)}} \qquad \gamma_n' = \frac{\sqrt{1-x^\star}\cos(t_n^\star)}{\sqrt{1+(1-x^\star)\sin^2(t_n^\star)}}.$$

Using again the integral identity, we obtain

$$\mathbb{E}_{\omega_1,\omega_2,t_i}\Big(a_i(\omega,t_i)\Big) = \frac{1}{N}\sum_n \Phi\Big(\frac{\alpha_n'}{\sqrt{1+\gamma_n'^2}}\Big) = \Phi\Big(\frac{\sqrt{x^\star}(N)}{\sqrt{2-x^\star(N)}}\omega_0\Big),$$

where we used the fact that $\cos^2(t_n^\star) + \sin^2(t_n^\star) = 1$, for all n. □

Proof of Proposition 4. Fix arbitrary I and N. Let $(x^\star(N), t_n^\star, p_n^\star)_{n=1}^N$ be the equilibrium profile of editorial strategies and prices. Let $r^\star(t_i) \in \{1, \ldots, N\}$ be the equilibrium information-acquisition strategy for a type t_i. Our first goal is to compute the ex ante utility $\mathcal{U}(N)$ of an arbitrary agent i. Fix a realization of agents' types $t = (t_1, \ldots, t_I)$. We have that:

$$\mathcal{U}(N|t) = \mathbb{E}_\omega(A_{-i}^\star(\omega)u(\omega, t_i)) + v((x^\star(N), t_n^\star)|t_i) - p_n^\star(t_i).$$

Therefore, the ex ante utility for agent i is

$$\mathcal{U}(N) = \mathbb{E}_{(t_1,\ldots,t_I)}\Big(\mathbb{E}_\omega(A_{-i}^\star(\omega)u(\omega, t_i)) + v((x^\star(N), t_{r^\star(t_i)}^\star)|t_i) - p_{r^\star(t_i)}^\star(t_i)\Big).$$

Note that the first term corresponds to the *indirect* value of information, $\mathcal{G}(N)$, the second term to the *direct* value of information, $\mathcal{V}^\star(N)$, and the last term is the expected price, $\mathcal{P}(N)$. To compute $\mathcal{U}(N)$, we proceed in steps. First, by the proof of Proposition 2.(a), we have that

$$\mathcal{V}(N) = \mathbb{E}_{(t_1,\ldots,t_I)}\Big(v((x^\star(N), t_{r^\star(t_i)}^\star)|t_i)\Big) = \mathbb{E}_{t_i}(v((x^\star(N), t_{r^\star(t_i)}^\star)|t_i)) = \mathcal{V}^\star(N) = \frac{\lambda}{\sqrt{x^\star(N)}}.$$

Second, we focus on $\mathcal{P}$. When $N = 1$, note that $\frac{\mathcal{P}(1)}{I} = \lambda$. If $N \geq 2$, instead, from the proof of Proposition 2.(b), we know that:

$$\mathbb{E}_{(t_1,\ldots,t_I)}(p_{r^\star(t_i)}^\star(t_i)) = \mathbb{E}_{t_i}(p_{r^\star(t_i)}^\star(t_i)) = \frac{\mathcal{P}(N)}{I} = 2\lambda\frac{1 - x^\star(N)}{\sqrt{x^\star(N)}}\Big(1 - \cos(\pi/N)\Big).$$

Lastly, we focus on the firm term of $\mathcal{U}(N)$. We have

$$\begin{aligned}\mathcal{G}(N) &= \mathbb{E}_{(t_1,\ldots,t_I)}\Big(\mathbb{E}_\omega(A_{-i}^\star(\omega)u(\omega, t_i))\Big)\\ &= \mathbb{E}_{t_{-i}}\Big(\mathbb{E}_\omega(A_{-i}^\star(\omega)\mathbb{E}_{t_i}u(\omega, t_i))\Big)\\ &= \mathbb{E}_{t_{-i}}\Big(\mathbb{E}_\omega(A_{-i}^\star(\omega)\omega_0)\Big)\\ &= \mathbb{E}_{\omega_0}\Big(\omega_0\mathbb{E}_{t_{-i}}(\mathbb{E}_{(\omega_1,\omega_2)}(A_{-i}^\star(\omega)))\Big),\end{aligned} \tag{A7}$$

where the second equality holds since $\mathbb{E}_{t_i}u(\omega, t_i) = \omega_0 + \frac{\omega_1}{2\pi}\int_{-\pi}^{\pi}\cos(t_i)dt_i + \frac{\omega_2}{2\pi}\int_{-\pi}^{\pi}\sin(t_i)dt_i = \omega_0$. Next, let us focus on the two inner-most expectations in the last expression. Recall that $A_{-i}^\star(\omega)$ is defined as $\frac{1}{I}\sum_{j\neq i} a_j^\star(\omega, t_j)$, where $a_j^\star(\omega, t_j)$ is the equilibrium approval decision of agent j. By Lemma A7, we have

$$\begin{aligned}\mathbb{E}_{\omega_1,\omega_2,t_{-i}}A_{-i}^\star(\omega_0, \omega_1, \omega_2)) &= \mathbb{E}_{\omega_1,\omega_2,t_{-i}}\frac{1}{I}\sum_{j\neq i} a_j^\star(\omega, t_j) = \frac{1}{I}\sum_{j\neq i}\mathbb{E}_{\omega_1,\omega_2,t_{-i}}a_j^\star(\omega, t_j)\\ &= \frac{1}{I}\sum_{j\neq i}\bar{a}_j(\omega_0) = \frac{I-1}{I}\Phi\Big(\frac{\sqrt{x^\star}(N)}{\sqrt{2 - x^\star(N)}}\omega_0\Big).\end{aligned} \tag{A8}$$

Putting equations (A7) and (A8) together, we obtain

$$\mathcal{G}(N) = \frac{I-1}{I}\mathbb{E}_{\omega_0}\Big(\omega_0\Phi\Big(\frac{\sqrt{x^\star}(N)}{\sqrt{2 - x^\star(N)}}\omega_0\Big)\Big).$$

Next, we use the integral identity $\int_{\mathbb{R}} y\Phi(\gamma y)\phi(y)dy = \frac{\gamma}{\sqrt{2\pi(1+\gamma^2)}}$ (see Patel and Read, 1996) and let $y = \omega_0$ and $\gamma = \sqrt{x^\star(N)}/\sqrt{2 - x^\star(N)}$ to obtain

$$\mathcal{G}(N) = \frac{I-1}{2I\sqrt{\pi}}\sqrt{x^\star(N)} = (I-1)\lambda\sqrt{x^\star(N)}.$$

Therefore, we established that, if $N \geq 2$,

$$\mathcal{U}(N) = \lambda\Big((I-1)\sqrt{x^\star(N)} + \frac{1}{\sqrt{x^\star(N)}} - 2\frac{1-x^\star(N)}{\sqrt{x^\star(N)}}(1-\cos(\pi/N))\Big) \tag{A9}$$

whereas $\mathcal{U}(1) = \lambda(I-1)$ when $N = 1$.

The second part of the proof consists of showing that, when letting $\bar{I} = 3(1+2\pi)$ and $I > \bar{I}$, $\mathcal{U}(N)$ is strictly decreasing in N. It can be directly verified that $\mathcal{U}(2) < \mathcal{U}(1)$ when $I > 4 = \bar{I}$. Therefore, the rest of the proof focuses on the case $N \geq 2$. To this purpose, let us ignore the constant term λ in $\mathcal{U}(N)$, let $\delta = \pi/N$, and let us write x in place of $x^\star(N)$, thus leaving the dependence on δ implicit. Our goal is to show that

$$G(\delta) = (I-1)\sqrt{x} + \frac{1}{\sqrt{x}} - 2\frac{1-x}{\sqrt{x}}(1-\cos(\delta))$$

is strictly *increasing* in $\delta \in (0, \pi/2]$. Taking the derivative with respect to δ, we obtain

$$\begin{aligned}
G'(\delta) &= \frac{1}{2}x^{-3/2}((I-1)x-1)x' + 2(1-\cos(\delta))\frac{x'}{x}\frac{1+x}{2\sqrt{x}} - 2\frac{1-x}{\sqrt{x}}\sin(\delta) \\
&\geq \frac{1}{2}x^{-3/2}((I-1)x-1)x' - 2\frac{1-x}{\sqrt{x}}\sin(\delta) \\
&= 2\frac{1-x}{\sqrt{x}}\Big(\frac{1}{4(1-x)}\frac{x'}{x}((I-1)x-1) - \sin(\delta)\Big).
\end{aligned}$$

The inequality holds since the middle term in the first expression is positive (by Proposition 1, x is strictly increasing in δ and, thus, $x' > 0$). Therefore, it is sufficient to show that

$$\frac{1}{4(1-x)}\frac{x'}{x}((I-1)x-1) - \sin(\delta) > 0.$$

Note that

$$x' = \frac{d}{d\delta}\left(\frac{\delta^2}{\delta^2+\sin^2(\delta)}\right) = \frac{2\delta(\sin^2(\delta) - \delta\sin(\delta)\cos(\delta))}{(\delta^2+\sin^2(\delta))^2} = \frac{2x}{\delta}\frac{(\sin^2(\delta) - \delta\sin(\delta)\cos(\delta))}{\delta^2+\sin^2(\delta)}.$$

By substituting x' into the previous inequality and letting $C = \frac{(I-1)x-1}{2(1-x)}$, we obtain

$$\frac{\sin(\delta)}{\delta^2+\sin^2(\delta)}\Big(C(\sin(\delta) - \delta\cos(\delta)) - \delta^3 - \delta\sin^2(\delta)\Big) > 0.$$

Since $\frac{\sin(\delta)}{\delta^2+\sin^2(\delta)} > 0$ for all $\delta \in (0, \pi]$, the proof is complete if we show that

$$F(\delta) = C(\sin(\delta) - \delta\cos(\delta)) - \delta^3 - \delta\sin^2(\delta) > 0.$$

To this purpose note that $F(0) = 0$. Moreover,

$$\begin{aligned} F'(\delta) &= \delta C \sin(\delta) - 3\delta^2 - \sin^2(\delta) - 2\delta \sin(\delta)\cos(\delta) \\ &= \delta^2\Big(C\frac{\sin(\delta)}{\delta} - 3 - (\frac{\sin(\delta)}{\delta})^2 - 2\cos(\delta)\frac{\sin(\delta)}{\delta}\Big) \\ &\geq \delta^2\Big(\frac{2C}{\pi} - 6\Big) \\ &\geq \delta^2\frac{I - 3(1+2\pi)}{\pi} > 0. \end{aligned}$$

The first inequality holds because $\cos(\delta) \leq 1$ and $\frac{\sin(\delta)}{\delta} \in [\frac{2}{\pi}, 1]$ for all $\delta \in (0, \pi/2]$. The second-to-last inequality holds instead because C is bounded below by $C \geq \frac{(I-3)}{2}$ (since $x \geq 1/2$). The last inequality holds because, by assumption, $I > \bar{I} = 3(1 + 2\pi)$. Therefore, $F'(\delta) > 0$ for all $\delta \in (0, \pi/2]$ and, thus, $F(\delta) > 0$. This implies that $G'(\delta) > 0$ and, thus, that $G(\delta)$ is strictly increasing for all $\delta \in (0, \pi/2]$. Hence, we conclude that $\mathcal{U}(N)$ is strictly decreasing in N for all $N \geq 1$. □

Remark A2. *For $I \geq 3$, $\mathcal{V}(N) + \mathcal{G}(N)$ is decreasing in N.*

Proof. As shown in the proof of Proposition 4, $\mathcal{V}(N) + \mathcal{G}(N) = \lambda(\frac{1}{\sqrt{x^\star(N)}} + (I-1)\sqrt{x^\star(N)})$. The sign of the derivative with respect to N is determined by $\left(\frac{-1}{x^\star(N)} + (I - N)\right)\frac{dx^\star(N)}{N}$. Since $x^\star(N) > 0.5$, the first term in the parentheses is positive whenever $I \geq 3$. Thus, the result follows from Proposition 1 which establishes $x^\star(N)$ to be decreasing in N. □

Proof of Remark 3. Fix $I \geq 1$ and $N \geq 1$. Let $(x^\star, t_n^\star)_{n=1}^N$ be the equilibrium profile of editorial strategies. Let $A^\star(\omega)$ be the equilibrium rate of approval. By assumption, it is equal to the probability that the society implements ω. We want to show that the total probability of implementing a policy in Ω^+, namely $\int_{\Omega^+} A^\star(\omega)\phi(\omega)d\omega$, decreases in N. To do so, we divide the proof in three steps. First, we partition the set of policies Ω^+. Second, we compute the integral restricting attention on an arbitrary cell of such partition. Third, we show that such integral is decreasing in N.

Step 1. For any $\omega_0 \in \mathbb{R}$ and $K \geq 0$, define the set of policies

$$\Omega^\circ(\omega_0, K) = \Big\{\tilde{\omega} \in \Omega : \tilde{\omega}_0 = \omega_0 \text{ and } \sqrt{\tilde{\omega}_1^2 + \tilde{\omega}_2^2} = K\Big\}.$$

Fix $\tilde{\omega} \in \Omega^\circ(\omega_0, K)$. Note that, by letting $t_{\tilde{\omega}} = \arctan(\tilde{\omega}_2/\tilde{\omega}_1) \in [-\pi, \pi]$, we can write $u(\tilde{\omega}, t_i) = \omega_0 + K\cos(t_i - t_{\tilde{\omega}})$. Moreover, all $\tilde{\omega} \in \Omega^\circ(\omega_0, K)$ are equally likely. To see this, note that $\Pr(\tilde{\omega}) = \phi(\tilde{\omega}_0)\phi(\tilde{\omega}_1)\phi(\tilde{\omega}_2) = \phi(\omega_0)\frac{1}{2\pi}e^{\frac{K^2}{2}}$, which only depends on (ω_0, K). Therefore, $t_{\tilde{\omega}}$ is uniformly distributed in $[-\pi, \pi]$.

Clearly, $(\omega_0', K') \neq (\omega_0'', K'')$, $\Omega^\circ(\omega_0', K') \cap \Omega^\circ(\omega_0'', K'') = \emptyset$. Moreover, let $C = \{(\omega_0, K) \in \mathbb{R}^2 \mid \omega_0 > K \geq 0\}$. We have that $\Omega^+ = \bigcup_{(\omega_0,K)\in C} \Omega^\circ(\omega_0, K)$. Too see this, let first $\omega \in \Omega^+$. Define $K = \sqrt{\omega_1 + \omega_2} \geq 0$. There is $t_\omega \in [-\pi, \pi]$ such that $u(\omega, t_i) = \omega_0 + K\cos(t_\omega - t_i) > 0$ for all t_i. Moreover, there is $\bar{t}_i \in [-\pi, \pi]$ such that $\cos(\bar{t}_i - t_\omega) = -1$. Therefore, $u(\omega, \bar{t}_i) = \omega_0 - K > 0$. Therefore, $(\omega_0, K) \in C$ and, thus, $\omega \in \Omega^\circ(\omega_0, K)$. Conversely, suppose $\hat{\omega} \in \Omega^\circ(\omega_0, K)$ for some $\omega_0 > K$. Since for all t_i $\cos(t_{\hat{\omega}} - t_i) \geq -1$, we have $0 < \omega_0 - K \leq \hat{\omega} - K\cos(t_{\hat{\omega}} - t_i) = u(\hat{\omega}, t_i)$ for all t_i. Therefore, $\hat{\omega} \in \Omega^+$. We conclude that $\{\Omega^\circ(\omega_0, K)\}_{(\omega_0,K)\in C}$ partitions Ω^+.

Step 2. Next, assume $\omega_0 > K \geq 0$, and focus on the set of policies $\Omega^\circ(\omega_0, K) \subset \Omega^+$. We want to show that the total probability of implementing these policies, namely $\frac{1}{2\pi}\int_{\Omega^\circ(\omega_0,K)} A^\star(\omega)d\omega$, decreases in N. We have that:

$$\begin{aligned}
\frac{1}{2\pi}\int_{\Omega^\circ(\omega_0,K)} A^\star(\omega)d\omega &= \frac{1}{2\pi I}\sum_i \int_{\Omega^\circ(\omega_0,K)} \bar{a}_i^\star(\omega, t_i)d\omega \\
&= \frac{1}{2\pi I}\sum_i \int_{-\pi}^{\pi} \Phi(\sqrt{x^\star}\omega_0 + \sqrt{1-x^\star}K\cos(t^\star_{n_i^\star} - t_\omega))dt_\omega \\
&= \frac{1}{2\pi I}\sum_i \int_0^{2\pi} \Phi(\sqrt{x^\star}\omega_0 + \sqrt{1-x^\star}K\cos(y))dy \\
&= \frac{1}{2\pi}\int_0^{\pi} \Phi(\sqrt{x^\star}\omega_0 + \sqrt{1-x^\star}K\cos(y)) + \\
&\quad \Phi(\sqrt{x^\star}\omega_0 - \sqrt{1-x^\star}K\cos(y))dy
\end{aligned}$$

The first and second equalities follows from the definition of approval rate and the proof of Lemma A7. In the second equality, we use notation $n_i^\star$ to indicate the firm from which agent i acquires information in equilibrium. To obtain the third equality, we used $y = t^\star_{n_i^\star} - t_{\tilde{\omega}}$ and the fact that for any l and u such that $u = l + 2\pi$, $\int_l^u -\cos(y)dy = \int_0^{2\pi}\cos(y)dy$. Finally, to obtain the fourth equality, we used $\cos(y+\pi) = -\cos(y)$.

Step 3. In order to show that $\frac{1}{2\pi}\int_{\Omega^\circ(\omega_0,K)} A^\star(\omega)d\omega$ is decreasing in N, it is sufficient to show that, for all $y \in [0,\pi]$, $\Phi(\sqrt{x^\star}\omega_0 + \sqrt{1-x^\star}K\cos(y)) + \Phi(\sqrt{x^\star}\omega_0 - \sqrt{1-x^\star}K\cos(y))$ is decreasing in N. To this purpose, fix $y \in [0,\pi]$. For notational convenience, let $\alpha = \sqrt{x^\star}$ and $\beta = \sqrt{1-x^\star}K$. We want to show that

$$\frac{d}{dN}\Big(\Phi(\alpha\omega_0 + \beta\cos(y)) + \Phi(\alpha\omega_0 - \beta\cos(y))\Big) < 0. \tag{A10}$$

This derivative is equal to:

$$\Big(\phi(\alpha\omega_0 + \beta\cos(y)) + \phi(\alpha\omega_0 - \beta\cos(y))\Big)\omega_0\alpha' + \Big(\phi(\alpha\omega_0 + \beta\cos(y)) - \phi(\alpha\omega_0 - \beta\cos(y))\Big)\cos(y)\beta'$$

We show that both terms of these derivatives are negative. Let us start from the first term. By assumption $\omega_0 > 0$, since $\omega_0 - K > 0$ and $K \geq 0$. Moreover, the probability density function $\phi(\cdot)$ is everywhere strictly positive. Finally, by Proposition 1, $\alpha' < 0$. Therefore, the first term is strictly negative. Next, we analyze the second term of the derivative. Suppose $\cos(y) \geq 0$. Then since $\omega_0 > 0$, $\alpha\omega_0 + \beta\cos(y) \geq \alpha\omega_0 - \beta\cos(y)$. Moreover, $\alpha\omega_0 > 0$. This implies that $\phi(\alpha\omega_0 + \beta\cos(y)) - \phi(\alpha\omega_0 - \beta\cos(y)) \leq 0$. Conversely, suppose $\cos(y) \leq 0$. Then $\alpha\omega_0 + \beta\cos(y) \leq \alpha\omega_0 - \beta\cos(y)$. Since $\alpha\omega_0 > 0$, this implies that $\phi(\alpha\omega_0 + \beta\cos(y)) - \phi(\alpha\omega_0 - \beta\cos(y)) \geq 0$. In summary, we showed that

$$\Big(\phi(\alpha\omega_0 + \beta\cos(y)) - \phi(\alpha\omega_0 - \beta\cos(y))\Big)\cos(y) \leq 0.$$

Since $\beta' > 0$ (Proposition 1), this implies that the second term of the derivative is weakly negative. We conclude that the derivative in Equation A10 is strictly negative, as we wanted to show. Since y was chosen arbitrary, this implies that $\frac{1}{2\pi}\int_{\Omega^\circ(\omega_0,K)} A^\star(\omega)d\omega$ is decreasing in N. Moreover, since $\Omega^\circ(\omega_0, K)$ is an arbitrary cell in the partition of Ω^+, we conclude that $\int_{\Omega^+} A^\star(\omega)\phi(\omega)d\omega$ is decreasing in N.

A similar argument can be made to prove that $\int_{\Omega^-} A^\star(\omega)\phi(\omega)d\omega$ is increasing in N. The only differences being that, in Step 1, we define $C' = \{(\omega_0, K) \in \mathbb{R}^2 \mid \omega_0 + K < 0, K \geq 0\}$ and, in Step 3, we use the fact that $\omega_0 < 0$. □

B. Extensions

B.1. Preference Heterogeneity– Proof of Proposition 5

Lemma B1 (Existence)**.** *Let f be regular, $N \geq 1$, and $I \geq 1$. An equilibirum of the game exists.*

Proof. We first establish that an equilibrium of the game exists. As in Section 3, we solve the game by backward induction. In the last stage of the game, each agent t_i observe the *realized* profile of (pure) editorial strategies and prices $(x_n, t_n, p_n)_{n=1}^N$. The agents' equilibrium strategies are determined by Lemmas 1 and 2. These results are independent of the distribution f and, thus, they equally apply to the case under consideration. In the second stage of the game, each firm observe the *realized* profile of (pure) editorial strategies and the vector of realized types $(t_1, \ldots, t_I)$ and choose a price $p_n(t_i)$ for each type. Since firms observe types and can set discriminatory prices, the equilibrium profile of prices is independent of the distribution f. As for the uniform case, given the *realized* profile of (pure) editorial strategies, the prevailing equilibrium price for firm n is $\max\{0, v((x_n, t_n)|t) - V((x_{n'}, t_{n'})_{n' \neq n}|t)\}$. Therefore, the expected profit for firm n is:

$$\Pi_n\Big((x_n, t_n)_{n=1}^N\Big) = I \int_{-\pi}^{\pi} \max\{0, v((x_n, t_n)|t) - V((x_{n'}, t_{n'})_{n' \neq n}|t)\} dF(t). \tag{B1}$$

Next, we argue that, for all n, $\Pi_n((x_n, t_n)_{n=1}^N)$ is continuous in $(x_n, t_n)_{n=1}^N$. To see this, let us consider an arbitrary sequence of editorial-strategy profiles $((x_n^k, t_n^k)_{n=1}^N)_k \subset ([1/2, 1] \times T)^N$ converging to $(x_n, t_n)_{n=1}^N$ as $k \to \infty$. We want to show that $\lim_{k\to\infty} \Pi_n((x_n^k, t_n^k)_{n=1}^N) = \Pi_n((x_n, t_n)_{n=1}^N)$. Clearly, the set $([1/2, 1]\times T)^N$ is compact. Moreover, $0 \leq \max\{0, v((x_n^k, t_n^k)|t) - V((x_{n'}^k, t_{n'}^k)_{n' \neq n}|t)\} \leq \lambda\sqrt{2}$ for all k and t. We have

$$\begin{aligned}
\lim_{k\to\infty} \Pi_n((x_n^k, t_n^k)_{n=1}^N) &= I \int_{-\pi}^{\pi} \lim_{k\to\infty} \max\{0, v((x_n^k, t_n^k)|t) - V((x_{n'}^k, t_{n'}^k)_{n' \neq n}|t)\} dF(t) \\
&= I \int_{-\pi}^{\pi} \max\{0, \lim_{k\to\infty} v((x_n^k, t_n^k)|t) - V((x_{n'}^k, t_{n'}^k)_{n' \neq n}|t)\} dF(t) \\
&= I \int_{-\pi}^{\pi} \max\{0, v((x_n, t_n)|t) - V((x_{n'}, t_{n'})_{n' \neq n}|t)\} dF(t) \\
&= \Pi_n((x_n, t_n)_{n=1}^N).
\end{aligned}$$

The first equality follows from the Dominated Convergence Theorem. The second equality holds as the max operator is continuous. The third equality follows because $v((x_n^k, t_n^k)|t) = \lambda(\sqrt{x_n^k} + \sqrt{1 - x_n^k} \cos(t - t_n^k))$ is continuous in (x_n^k, t_n^k) for all n. Therefore, $v((x_n, t_n)|t) - V((x_{n'}, t_{n'})_{n' \neq n}|t)$ is continuous. Therefore, for all n, the strategy space is compact and the payoff function $\Pi_n\Big((x_n, t_n)_{n=1}^N\Big)$ is continuous. By

Glicksberg's theorem, the first stage of the game admits a Nash Equilibrium in mixed editorial strategies. Therefore, by backward induction, the game admits an equilibrium. □

Lemma B2 (Daily Me I)**.** *Let F be regular and $I \geq 1$. Denote by $v_{t_i}(N)$ the expected value of information for type t_i in an arbitrary equilibrium with N firms. Then,* $\lim_{N\to\infty} v^*_{t_i}(N) = \bar{\mathcal{V}}$.

Proof Fix $\delta > 0$ and let $\xi_1 = \frac{\delta}{2\lambda}$. Let $\bar{\mathcal{V}} = \max_{(x_n,t_n)} v((x_n,t_n|t_i) = \lambda\sqrt{2}$. This is the highest possible value that $v((x_n,t_n|t_i)$ can achieve and it is independent of t_i. We show that there exists $\bar{N}$ such that, for all $N > \bar{N}$ and any equilibrium profile of possibly mixed editorial strategies $\chi \in (\Delta([1/2,1]\times T))^N$ we have $\mathbb{E}_\chi(\max_n\{v(x_n,t_n|t_i)\}) > \bar{\mathcal{V}} - \delta$ for all $t_i \in T$. Suppose not. That is suppose that, for all N, there is an equilibrium profile of possibly mixed editorial strategies χ and a type $\bar{t}_i$ such that $\mathbb{E}_\chi(\max_n\{v(x_n,t_n|t_i)\}) \leq \bar{\mathcal{V}} - \delta$.

This implies that, for all $t_j \in [\bar{t}_i - \xi_1, \bar{t}_i + \xi_1]$, $\mathbb{E}_\chi(\max_n\{v(x_n,t_n|t_j)\}) \leq \bar{\mathcal{V}} - \frac{\delta}{2}$. To see this, suppose, by way of contradiction, that $\mathbb{E}_\chi(\max_n\{v(x_n,t_n|t_j)\}) > \bar{\mathcal{V}} - \frac{\delta}{2}$. Denote by $n(t_j)$ the random variable that, for each realization of χ, indicates the firm from which t_j acquires information. Note that, for all $t_n \in T$, $\cos(\bar{t}_i - t_n) \geq \cos(t_j - t_n) - \xi_1$, since $\frac{d}{dt}\cos(t - t_n) \leq 1$. We have that,

$$\begin{aligned}
\mathbb{E}_\chi(\max_n\{v((x_n,t_n)|t_i)\}) &\geq \mathbb{E}_\chi(v((x_{n(t_j)},t_{n(t_j)})|t_i)) \\
&= \lambda\mathbb{E}_\chi(\sqrt{x_{n(t_j)}} + \sqrt{1-x_{n(t_j)}}\cos(\bar{t}_i - t_{n(t_j)})) \\
&\geq \lambda\mathbb{E}_\chi(\sqrt{x_{n(t_j)}} + \sqrt{1-x_{n(t_j)}}(\cos(t_j - t_{n(t_j)}) - \xi_1)) \\
&\geq \lambda\mathbb{E}_\chi(\sqrt{x_{n(t_j)}} + \sqrt{1-x_{n(t_j)}}\cos(t_j - t_{n(t_j)})) - \xi_1 \\
&\geq \mathbb{E}_\chi(\max_n\{v(x_n,t_n|t_j)\}) - \lambda\xi_1 \\
&> \bar{\mathcal{V}} - \tfrac{\delta}{2} - \lambda\xi_1 \\
&= \bar{\mathcal{V}} - \delta.
\end{aligned}$$

The first inequality holds as, in the right-hand side, agent $\bar{t}_i$ chooses the firm $n(t_j)$ that is optimal for t_j. The second inequality holds since $\cos(\bar{t}_i - t_n) \geq \cos(t_j - t_n) - \xi_1$ for all t_n. In summary, this contradicts our assumption that $\mathbb{E}_\chi(\max_n\{v(x_n,t_n|t_i)\}) \leq \bar{\mathcal{V}} - \delta$. Therefore, it must be that $\mathbb{E}_\chi(\max_n\{v(x_n,t_n|t_j)\}) \leq \bar{\mathcal{V}} - \frac{\delta}{2}$.

Note that, by continuity of $v((x_n,t_n)|t_j)$ in t_j, there exists $\xi_2 > 0$ such that for all $t_j \in [\bar{t}_i - \xi_2, \bar{t}_i + \xi_2]$ such that $v((1/2,\bar{t}_i)|t_j) \geq \bar{\mathcal{V}} - \frac{\delta}{4}$. Moreover, such ξ_2 is independent of N. Let $\xi = \min\{\xi_1,\xi_2\}$, which in turn is independent of N. We have established that for all $t_j \in [\bar{t}_i - \xi, \bar{t}_i + \xi]$,

$$\mathbb{E}_\chi(\max_{n\neq n'}\{v(x_{n'},t_{n'}|t_j)\}) \leq \mathbb{E}_\chi(\max_n\{v(x_n,t_n|t_j)\}) \leq \bar{\mathcal{V}} - \frac{\delta}{2} < \bar{\mathcal{V}} - \frac{\delta}{4} \leq v((1/2,\bar{t}_i)|t_j), \tag{B2}$$

Consider an arbitrary firm n who deviates from its equilibrium editorial strategy (χ_n) in favor of the pure strategy ($x_n = 1/2, t_n = \bar{t}_i$). Its expected profits are

$$\begin{aligned}
\Pi_n((x_n,t_n),(\chi_{n'},\tau_{n'})_{n'\neq n}) &= I\int_{-\pi}^{\pi}\mathbb{E}_{\chi}\Big(\max\{v((x_n,t_n)|t_j)-V((x_{n'},t_{n'})_{n'\neq n}|t_j),0\}\Big)dF(t_j)\\
&\geq I\int_{\bar{t}_i-\xi}^{\bar{t}_i+\xi}\mathbb{E}_{\chi}\Big(\max\{v((x_n,t_n)|t_j)-V((x_{n'},t_{n'})_{n'\neq n}|t_j),0\}\Big)dF(t_j)\\
&\geq I\int_{\bar{t}_i-\xi}^{\bar{t}_i+\xi}\mathbb{E}_{\chi}\Big(v((x_n,t_n)|t_j)-V((x_{n'},t_{n'})_{n'\neq n}|t_j)\Big)dF(t_j)\\
&\geq I\int_{\bar{t}_i-\xi}^{\bar{t}_i+\xi}v((x_n,t_n)|t_j)-\mathbb{E}_{\chi}(V((x_{n'},t_{n'})_{n'\neq n}|t_j))dF(t_j)\\
&= I\int_{\bar{t}_i-\xi}^{\bar{t}_i+\xi}v((x_n,t_n)|t_j)-\mathbb{E}_{\chi}(\max_{n'\neq n}\{v(x_{n'},t_{n'}|t_j)\})dF(t_j)\\
&\geq I\int_{\bar{t}_i-\xi}^{\bar{t}_i+\xi}\Big(\bar{\mathcal{V}}-\frac{\delta}{4}-\bar{\mathcal{V}}+\frac{\delta}{2}\Big)f(t_j)dt_j\\
&\geq \frac{IC\delta\xi}{2}.
\end{aligned}$$

The first inequality holds since the integrand function is everywhere positive. The second inequality holds by monotonicity of the operator $\mathbb{E}_{\chi}$. The second-to-last inequality obtains as a consequence of Equation (B2). The last inequality, instead, obtains because $f(t_j) \geq C > 0$ for all t_j. We established that firm n can secure an expected profit of at least $\frac{IC\delta\xi}{2}$ by deviating to ($x_n = 1/2, t_n = \bar{t}_i$). This lower bound is strictly positive and independent of N. To conclude the proof, note that that the industry profits are bounded above by $I\bar{\mathcal{V}}$. Therefore, when N firms are competing, there is at least one firm, which we denote by n, whose expected equilibrium profits is $\Pi_n(\chi) \leq I\bar{\mathcal{V}}/N$. When N is large, $\frac{IC\delta\xi}{2} > I\bar{\mathcal{V}}/N$ and firm n as a strictly profitable deviation from its equilibrium editorial strategy (χ_n) in the first stage of the game. □

Lemma B3 (Daily Me II)**.** *Let f be regular and $I \geq 1$. For any t_i, denote by $(x^N_{n(t_i)}, t^N_{n(t_i)})$ the random variable specifying the information structure that agent t_i acquires in an equilibrium with N firms. Then, $(x^N_{n(t_i)}, t^N_{n(t_i)}) \to (1/2, t_i)$ in probability as $N \to \infty$.*

Proof. Fix t_i, $\epsilon > 0$, and a sequence of equilibria. For any N, denote by $(x^N_{n(t_i)}, t^N_{n(t_i)})$ the random variable specifying the information structure that agent t_i acquires in equilibrium. We want to show that, for all $\delta > 0$, there exists $\bar{N}$ such that for all $N > \bar{N}$, $Pr(\|(x^N_{n(t_i)}, t^N_{n(t_i)}) - (1/2, t_i)\| > \epsilon) < \delta$. Suppose not. Then, there is $\delta > 0$ such that for all $\bar{N}$ there is $N > \bar{N}$ such that $Pr(\|(x^N_{n(t_i)}, t^N_{n(t_i)}) - (1/2, t_i)\| > \epsilon) \geq \delta$. Let (x_n, t_n) be a realization of $(x^N_{n(t_i)}, t^N_{n(t_i)})$ such that $\|(x_n, t_n) - (1/2, t_i)\| > \epsilon$. That is, $\sqrt{(x_n - 1/2)^2 + (t_n - t_i)^2} > \epsilon$. This implies that

$$\max\{|x_n - 1/2|, |t_n - t_i|\} > \frac{\epsilon}{\sqrt{2}}.$$

Consider the difference $\bar{\mathcal{V}} - v((x_n, t_n)|t) = \lambda(\sqrt{2} - (\sqrt{x_n} + \sqrt{1 - x_n}\cos(t_n - t_i)))$. Suppose $|t_n - t_j| > \frac{\epsilon}{\sqrt{2}}$. Then,

$$\bar{\mathcal{V}} - v((x_n, t_n)|t) \geq \frac{\lambda}{\sqrt{2}}(1 - \cos(t_n - t_j)) > \frac{\lambda}{\sqrt{2}}(1 - \cos(\frac{\epsilon}{\sqrt{2}})) =: K_1(\epsilon) > 0.$$

Conversely, suppose that $|x_n - 1/2| > \frac{\epsilon}{\sqrt{2}}$. Then,

$$\bar{\mathcal{V}} - v((x_n, t_n)|t) \geq \lambda(\sqrt{2} - \sqrt{x_n} - \sqrt{1 - x_n}) > \lambda\Big(\sqrt{2} - \frac{1}{2}(\sqrt{1 + \epsilon\sqrt{2}} + \sqrt{1 - \epsilon\sqrt{2}})\Big) =: K_2(\epsilon) > 0$$

Let $K(\epsilon) = \min\{K_1(\epsilon), K_2(\epsilon)\}$. We established that, for all realizations of the random variable $(x^N_{n(t_i)}, t^N_{n(t_i)})$ that satisfy $\|(x^N_{n(t_i)}, t^N_{n(t_i)}) - (1/2, t_i)\| > \epsilon$, we have $\bar{\mathcal{V}} - v((x_n, t_n)|t) > K(\epsilon) > 0$. This implies that

$$Pr\Big(\Big\|\bar{\mathcal{V}} - v((x^N_{n(t_i)}, t^N_{n(t_i)}\Big|t_i)\Big\| > K(\epsilon)\Big) \geq \delta.$$

Since δ and ϵ are independent of N, we conclude that $\mathbb{E}(v((x^N_{n(t_i)}, t^N_{n(t_i)}\big|t_i))$ does not converge to $\bar{\mathcal{V}}$, a contradiction. □

Lemma B4. *Let f be regular and $I \geq 1$. For any sequence of equilibria indexed by N,*

$$\mathcal{U}(N) \to \frac{I-1}{I}\mathbb{E}_{\omega,t_i,t_j}\Big(\Phi(\frac{1}{\sqrt{2}}u_j(\omega, t_j))u_i(\omega, t_i)\Big) + \bar{\mathcal{V}}.$$

Proof. Fix $N \geq 1$. Let χ be an equilibrium profile of (possibly mixed) editorial strategies. Denote by $(x_{n(t_i)}, t_{n(t_i)})$ the equilibrium random variable which specifies the information structure that is chosen by agent t_i among those that are offered by the N firms. As such $(x_{n(t_i)}, t_{n(t_i)})$ depends on N, χ, and $r^\star(t_i)$. To simplify notation, we leave such dependence implicit. As shown in the proof of Lemma 2 and Proposition 4, the ex ante utility for an agent can be written as follows once we account for the additional randomness induced χ:

$$\mathcal{U}(N) = \mathbb{E}_\chi\mathbb{E}_{(t_1,\ldots,t_I)}\Big(\mathbb{E}_\omega(A_{-i}(\omega)u(\omega, t_i)) + v((x_{n(t_i)}, t_{n(t_i)}|t_i) - p_{n(t_i)}(t_i)\Big). \tag{B3}$$

We begin by showing that

$$\lim_{N\to\infty}\mathbb{E}_\chi\mathbb{E}_{t_i}\Big(v((x_{n(t_i)}, t_{n(t_i)}|t_i) - p_{n(t_i)}(t_i)\Big) = \bar{\mathcal{V}}. \tag{B4}$$

To see this, fix t_i. We want to show that $\lim_{N\to\infty}\mathbb{E}_\chi(p_{n(t_i)}(t_i)) = 0$. For each N, recall that $p_{n(t_i)}(t_i) = v((x_{n(t_i)}, t_{n(t_j)}) - \max_{m\neq n(t_i)} v((x_m, t_m)|t_i)$. Thanks to Lemma B2, it is enough to show that $\lim_{N\to\infty}\mathbb{E}_\chi(\max_{m\neq n(t_i)} v((x_m, t_m)|t_i))$ $\bar{\mathcal{V}}$. In Lemma B3, we established that, for all t_i, $(x_{n(t_i)}, t_{n(t_i)}) \to (1/2, t_i)$ in probability. This implies that, for any $t_j \neq t_i$, as N goes to infinity, $Pr(n(t_i) = n(t_j)) \to 0$. This implies that

$$\lim_{N\to\infty} Pr\left(v((x_{n(t_j)}, t_{n(t_j)})|t_i) - \max_{n\neq n(t_i)} v((x_n, t_n)|t_i) < 0\right) = 1.$$

By the Continuous Mapping Theorem, the fact that $(x_{n(t_j)}, t_{n(t_j)})$ converges to $(1/2, t_j)$ in probability implies that $v((x_{n(t_j)}, t_{n(t_j)})|t_i) \to v((1/2, t_j)|t_i)$ in probability. Now fix any $\epsilon > 0$ and $\delta > 0$. There exists t_j close enough to t_i such that $\bar{\mathcal{V}} - v((1/2, t_j)|t_i) < \epsilon$. Therefore,

$$Pr\left(\bar{\mathcal{V}} - \max_{n\neq n(t_i)} v((x_n, t_n)|t_i) < \epsilon\right) > 1 - \delta.$$

That is, $\max_{n\neq n(t_i)} v((x_n, t_n)|t_i)$ converges to $\bar{\mathcal{V}}$ in probability. Since $|v|$ is bounded, convergence in probability implies convergence in expectation. That is, $\mathbb{E}_\chi(\max_{m\neq n(t_i)} v((x_m, t_m)|t_i))$ converges to $\bar{\mathcal{V}}$. Together with Step 2, this shows that, for any t_i, $\lim_{N\to\infty} \mathbb{E}_\chi(v((x_{n(t_i)}, t_{n(t_i)}|t_i) - p_{n(t_i)}(t_i)) = \bar{\mathcal{V}}$. Since t_i was arbitrary and its distribution is independent of χ, Equation B4 holds.

We are left to show that the first term in Equation B3 converges to

$$\frac{I-1}{I}\mathbb{E}_{\omega,t_i,t_j}(\Phi(\frac{1}{\sqrt{2}}u_j(\omega, t_j))u_i(\omega, t_i)).$$

To this purpose, recall that

$$A_{-i}(\omega) = \frac{1}{I}\sum_{j\neq i} a_j(\omega, t_j) = \frac{1}{I}\sum_{j\neq i}\Phi\Big(\sqrt{x_{n(t_j)}}\omega_0 + \sqrt{1 - x_{n(t_j)}}\big(\cos(t_{n(t_j)})\omega_1 + \sin(t_{n(t_j)})\omega_2\big)\Big).$$

Moreover, note that χ, ω and $(t_1, \ldots, t_I)$ are mutually independent random variables. Therefore, swapping the order of integration and defining $U_i(\omega) = \mathbb{E}_{t_i}u(\omega, t_i)$ to simplify notation, we obtain

$$\begin{aligned}\lim_{N\to\infty} \mathbb{E}_\chi\mathbb{E}_{(t_1,\ldots,t_I)}\Big(\mathbb{E}_\omega(A_{-i}(\omega)u(\omega, t_i))\Big) &= \tfrac{1}{I}\lim_{N\to\infty} \mathbb{E}_\omega\Big(\textstyle\sum_{j\neq i}\mathbb{E}_{t_j}\mathbb{E}_\chi a_j(\omega, t_j)\mathbb{E}_{t_i}u(\omega, t_i)\Big)\\ &= \tfrac{(I-1)}{I}\lim_{N\to\infty} \mathbb{E}_\omega\Big(\mathbb{E}_{t_j}\mathbb{E}_\chi a_j(\omega, t_j)\mathbb{E}_{t_i}u(\omega, t_i)\Big)\\ &= \tfrac{(I-1)}{I}\lim_{N\to\infty} \mathbb{E}_\omega\Big(\mathbb{E}_{t_j}\mathbb{E}_\chi a_j(\omega, t_j)U_i(\omega)\Big).\end{aligned}$$

Fix (ω, t_j). By Lemma B3, the random variable $(x_{n(t_i)}, t_{n(t_i)})$ converges in probability to the constant $(\frac{1}{2}, t_j)$. Since $\Phi(\cdot)$ is continuous,

$$\Phi\Big(\sqrt{x_{n(t_j)}}\omega_0 + \sqrt{1 - x_{n(t_j)}}\big(\cos(t_{n(t_j)})\omega_1 + \sin(t_{n(t_j)})\omega_2\big)\Big) \to \Phi(\frac{1}{\sqrt{2}}u_j(\omega, t_j))$$

in probability, by the continuous mapping theorem. Moreover, since $\Phi(\cdot) \in [0, 1]$, convergence in probability implies convergence in expectation. That is,

$$\lim_{N\to\infty} \mathbb{E}_\chi a(\omega, t_i) = \Phi(\frac{1}{\sqrt{2}}u_j(\omega, t_j)).$$

Moreover, since $a_j(\omega, t_j) \leq 1$, for all χ, $U_i(\omega)\mathbb{E}_\chi a_j(\omega, t_j) \leq U_i(\omega)$, and $\mathbb{E}_\omega U_i(\omega) \in \mathbb{R}$. Therefore, by the Dominated Convergence Theorem,

$$\begin{aligned}\lim_{N\to\infty} \mathbb{E}_\chi\mathbb{E}_{(t_1,\ldots,t_I)}\Big(\mathbb{E}_\omega(A_{-i}(\omega)u(\omega, t_i))\Big) &= \tfrac{(I-1)}{I}\lim_{N\to\infty} \mathbb{E}_\omega\Big(\mathbb{E}_{t_j}\mathbb{E}_\chi a_j(\omega, t_j)U_i(\omega)\Big)\\ &= \tfrac{(I-1)}{I}\mathbb{E}_\omega\Big(\mathbb{E}_{t_j}\lim_{N\to\infty} \mathbb{E}_\chi a_j(\omega, t_j)U_i(\omega)\Big)\\ &= \tfrac{(I-1)}{I}\mathbb{E}_{\omega,t_i,t_j}\Big(\Phi(\tfrac{1}{\sqrt{2}}u_j(\omega, t_j))u_i(\omega, t_i)\Big)\end{aligned}$$

which concludes the proof. □

Lemma B5. *For any regular f, there exists $\bar{I}$ such that, for all $I > \bar{I}$, the ex-ante utility of a typical agent is higher under monopoly than perfect competition. That is, $\mathcal{U}(1) > \lim_{N\to\infty}\mathcal{U}(N)$.*

Proof. We first compute $\mathcal{U}(1)$ and then compute $\lim_{N\to\infty}\mathcal{U}(N)$.

(Monopoly, $N = 1$). Fix f and let $N = 1$. By definition f is symmetric around zero. Type $t_i = 0$ is the mean and median type according to distribution f. The monopolistic firm chooses $(x^\star, t^\star)$ to maximize

$I\int_{-\pi}^{\pi} v((x^\star,t^\star)|t_i)f(t_i)dt_i = \lambda I\int_{-\pi}^{\pi} \sqrt{x^\star} + \sqrt{1-x^\star}\cos(t^\star - t_i)f(t_i)dt_i$. The first-order condition with respect to t implies $-\int \sin(t^\star - t_i)f(t_i)dt_i = 0$. By symmetry of f around t^m, the first-order condition is met at $t^\star \in \{t^m, t^m + \pi \pmod{\pi}\} \subset [-\pi,\pi]$. The second order condition with respect to t implies $-\int \cos(t^\star - t_i)f(t_i)dt_i \leq 0$. Since $\cos(t+\pi) = -\cos(t)$, we have that either $\int \cos(t^m - t_i)f(t_i)dt_i \geq 0$ or $\int \cos(t^m + \pi - t_i)f(t_i)dt_i \geq 0$ (or both). Without loss of generality let t^m be the type at which $\int \cos(t^m - t_i)f(t_i)dt_i \geq 0$. Therefore, the monopolist locates at $t^\star = t^m$. Define $\beta_F = \int \cos(t^m - t_i)f(t_i)dt_i \in [0,1]$. Given this, we can rewrite the monopoly profits for an arbitrary x as $I(\sqrt{x} + \sqrt{1-x}\beta_F)$. The first-order condition with respect to x gives $\sqrt{1-x^\star} = \beta_F\sqrt{x^\star}$ which implies $x^\star = \frac{1}{1+\beta_F^2}$. Hence, we established that the equilibrium editorial strategy chosen by a monopolist is $(\frac{1}{1+\beta_F^2}, t^m)$.

We now compute $\mathcal{U}(1)$. We begin by establishing that:

$$\mathbb{E}_{t_i}(u(\omega,t_i)) = \omega_0 + \beta_F\big(\cos(t^m)\omega_1 + \sin(t^m)\omega_2\big). \tag{B5}$$

To see this, notice that

$$\begin{aligned}
\mathbb{E}_{t_i}(u(\omega,t_i)) &= \omega_0 + \textstyle\int_{-\pi}^{\pi}(\cos(t_i)\omega_1 + \sin(t_i)\omega_2)f(t_i)dt_i \\
&= \omega_0 + \Big(\cos(t^m)\textstyle\int\cos(t_i - t^m)f(t_i)dt_i - \sin(t^m)\int\sin(t_i - t^m)f(t_i)dt_i\Big)\omega_1 \\
&\quad + \Big(\sin(t^m)\textstyle\int\cos(t_i - t^m)f(t_i)dt_i - \cos(t^m)\int\sin(t_i - t^m)f(t_i)dt_i\Big)\omega_2 \\
&= \omega_0 + \beta_F\left(\cos(t^m)\omega_1 + \sin(t^m)\omega_2\right)
\end{aligned}$$

In the first equality, we used $t_i = t^m + (t_i - t^m)$ and the following two trigonometric identities: $\sin(\alpha+\beta) = \sin(\alpha)\cos(\beta) + \cos(\alpha)\sin(\beta)$ and $\cos(\alpha+\beta) = \cos(\alpha)\cos(\beta) - \sin(\alpha)\sin(\beta)$. In the second equality, we used that f is symmetric around t_m (implying $\int \sin(t^m - t)f(t)dt = 0$) and the definition of β_F.

Equation B3 characterizes the ex-ante utility for a typical agent. When $N = 1$, $p^\star(t_i) = v((x^\star,t^\star)|t_i)$ for all t_i. That is, the monopolist extracts all surplus from each type. Therefore, the last two terms of Equation B3. Thus, using the mutual independence between ω and $(t_1,\ldots,t_I)$, we have

$$\begin{aligned}
\mathcal{U}(1) &= \mathbb{E}_{(t_1,\ldots,t_I)}\Big(\mathbb{E}_\omega(A^\star_{-i}(\omega)u(\omega,t_i))\Big) \\
&= \mathbb{E}_w\Big(\mathbb{E}_{t_{-i}}(A^\star_{-i}(\omega))\mathbb{E}_{t_i}(u(\omega,t_i))\Big) \\
&= \mathbb{E}_w\Big(\mathbb{E}_{t_{-i}}(A^\star_{-i}(\omega))(\omega_0 + \beta_F(\cos(t^m)\omega_1 + \sin(t^m)\omega_2))\Big) \\
&= \mathbb{E}_\omega\Big(\tfrac{I-1}{I}\mathbb{E}_{t_j}(a^\star(\omega,t_j))(\omega_0 + \beta_F(\cos(t^m)\omega_1 + \sin(t^m)\omega_2))\Big) \\
&= \mathbb{E}_\omega\Big(\tfrac{I-1}{I}\Phi(\sqrt{x^\star}\omega_0 + \sqrt{1-x^\star}(\cos(t^m)\omega_1 + \sin(t^m)\omega_2))(\omega_0 + \beta_F(\cos(t^m)\omega_1 + \sin(t^m)\omega_2))\Big)
\end{aligned} \tag{B6}$$

Next, denote $y = \cos(t^m)\omega_1 + \sin(t^m)\omega_2 \sim \mathcal{N}(0,1)$, $a = \sqrt{x^\star}$, and $b = \sqrt{1-x^\star}$. We have

$$\begin{aligned}
\mathcal{U}(1) &= \tfrac{I-1}{I}\mathbb{E}_{\omega_0}\Big(\mathbb{E}_y\left(\Phi(a\omega_0 + by)(\omega_0 + \beta_F y)\right)\Big) \\
&= \tfrac{I-1}{I}\mathbb{E}_{\omega_0}\mathbb{E}_y\left(\Phi(a\omega_0 + by)(\omega_0 + \beta_F y)\right) \\
&= \tfrac{I-1}{I}\mathbb{E}_{\omega_0}\Big(\omega_0\mathbb{E}_y\left(\Phi(a\omega_0 + by)\right) + \beta_F\mathbb{E}_y\left(y\Phi(a\omega_0 + by)\right)\Big) \\
&= \tfrac{I-1}{I}\mathbb{E}_{\omega_0}\Big(\omega_0\Phi\Big(\tfrac{a\omega_0}{\sqrt{1+b^2}}\Big) + \tfrac{\beta_F b}{\sqrt{1+b^2}}\phi\Big(\tfrac{a\omega_0}{\sqrt{1+b^2}}\Big)\Big)
\end{aligned}$$

The last line makes use of the properties of the normal distribution. Specifically, since $y \sim N(0,1)$, we have that, for all $\alpha, \gamma \in \mathbb{R}$, $\mathbb{E}_y(\Phi(\alpha + \gamma y)) = \Phi(\frac{\alpha}{\sqrt{1+\gamma^2}})$ and $\mathbb{E}_y(y\Phi(\alpha + \gamma y)) = \frac{\gamma}{\sqrt{1+\gamma^2}}\phi(\frac{\alpha}{\sqrt{1+\gamma^2}})$ (for both, see Patel and Read, 1996).

Finally, we integrate with respect to w_0. Define $\tilde{b} = \frac{a}{\sqrt{1+b^2}}$. We have:

$$\begin{aligned} \mathcal{U}(1) &= \tfrac{I-1}{I}\mathbb{E}_{\omega_0}\Big(\omega_0\Phi(\tilde{b}\omega_0) + \tfrac{\beta_F b}{\sqrt{1+b^2}}\phi(\tilde{b}\omega_0)\Big) \\ &= \tfrac{I-1}{I}\Big(\tfrac{\tilde{b}}{\sqrt{1+\tilde{b}^2}}\phi(0) + \tfrac{\beta_F b}{\sqrt{1+b^2}}\tfrac{1}{\sqrt{1+\tilde{b}^2}}\phi(0)\Big) \\ &= \tfrac{I-1}{I2\sqrt{\pi}}\left(\sqrt{x^\star} + \beta_F\sqrt{1-x^\star}\right) \\ &= (I-1)\lambda\sqrt{1+\beta_F^2} \end{aligned}$$

In the second line, we used once again the integral properties of the normal distributed listed before. In the third line, we substituted the definitions of $\tilde{b}$, b, and a and used the fact that $\phi(0) = 1/\sqrt{2\pi}$. In the last line, we used $x^\star = \frac{1}{1+\beta_F^2}$ and $\lambda = \frac{1}{2I\sqrt{\pi}}$. In passing, note that $\beta_F = 0$ if f is uniform. In such case, the value of $\mathcal{U}(1)$ matches the one computed in the Proof of Proposition 4.

(Perfect Competition, $N = \infty$). Lemma B4 showed that, for any sequence of equilibria indexed by N,

$$\lim_{N\to\infty}\mathcal{U}(N) = \frac{I-1}{I}\mathbb{E}_{\omega,t_i,t_j}\Big(\Phi(\frac{1}{\sqrt{2}}u_j(\omega,t_j))u_i(\omega,t_i)\Big) + \bar{\mathcal{V}}.$$

We begin by focusing on the first term of the right-hand side. Note that

$$\begin{aligned} &\mathbb{E}_{\omega,t_i,t_j}\Big(\Phi(\tfrac{1}{\sqrt{2}}u_j(\omega,t_j))u_i(\omega,t_i)\Big) \\ =\ &\mathbb{E}_{\omega,t_j}\Big(\Phi(\tfrac{1}{\sqrt{2}}u_j(\omega,t_j))\mathbb{E}_{t_i}u_i(\omega,t_i)\Big) \\ =\ &\mathbb{E}_{\omega,t_j}\Big(\Phi(\tfrac{1}{\sqrt{2}}(\omega_0 + \cos(t_j)\omega_1 + \sin(t_j)\omega_2))(\omega_0 + \beta_F(\cos(t^m)\omega_1 + \sin(t^m)\omega_2))\Big), \end{aligned}$$

where we used Equation B5 and the fact that (ω, t_i, t_j) are independent.

Fix any t_j and consider first the expectation with respect to ω. To simplify notation, let us write $t_j = t$ and $a = b = 1/\sqrt{2}$. Then,

$$\begin{aligned} &\mathbb{E}_\omega\Big(\Phi(a\omega_0 + b(\cos(t)\omega_1 + \sin(t)\omega_2)))(\omega_0 + \beta_F(\cos(t^m)\omega_1 + \sin(t^m)\omega_2))\Big) \\ =\ &\mathbb{E}_\omega(\omega_0\Phi(a\omega_0 + b(\cos(t)\omega_1 + \sin(t)\omega_2))))+ \\ &\beta_F\cos(t^m)\mathbb{E}_\omega(\Phi(a\omega_0 + b(\cos(t)\omega_1 + \sin(t)\omega_2)))\omega_1)+ \\ &\beta_F\sin(t^m)\mathbb{E}_\omega(\Phi(a\omega_0 + b(\cos(t)\omega_1 + \sin(t)\omega_2)))\omega_2)\omega_2)) \end{aligned}$$

We compute this expectation term by term. We begin with the first term. Let $y_t = \cos(t_j)\omega_1 + \sin(t_j)\omega_2$ and note that $y_t \sim \mathcal{N}(0,1)$. Define $\tilde{b} = \frac{a}{\sqrt{1+b^2}}$. Then, using the independence of $(\omega_0, \omega_1, \omega_2)$, we have

$$\begin{aligned} \mathbb{E}_\omega(\omega_0\Phi(a\omega_0 + b(\cos(t)\omega_1 + \sin(t)\omega_2)))) &= \mathbb{E}_{\omega_0}(\omega_0\mathbb{E}_{y_t}\Phi(a\omega_0 + by_t)) \\ &= \mathbb{E}_{\omega_0}(\omega_0\Phi(\tfrac{a}{\sqrt{1+b^2}}\omega_0)) \\ &= \tfrac{\tilde{b}}{\sqrt{1+\tilde{b}^2}}\phi(0) \\ &= \tfrac{1}{2}\phi(0). \end{aligned}$$

We now focus on the second term. We first integrate ω_1, then ω_2, and finally ω_0. As we have done before, we use the integral identity $\mathbb{E}_z(z\Phi(\alpha + \gamma z)) = \frac{\gamma}{\sqrt{1+\gamma^2}}\phi(\frac{\alpha}{\sqrt{1+\gamma^2}})$ for all $\alpha, \gamma \in \mathbb{R}$ and $z \sim N(0,1)$. Moreover, we use a new integral identity that gives us $\mathbb{E}(\phi(\alpha + \gamma z)) = \frac{1}{\sqrt{1+\gamma^2}}\phi(\frac{\alpha}{\sqrt{1+\gamma^2}})$ (see Patel and Read, 1996). We obtain:

$$\begin{aligned} & \mathbb{E}_\omega(\Phi(a\omega_0 + b(\cos(t)\omega_1 + \sin(t)\omega_2)))\omega_1) \\ = \ & \mathbb{E}_{\omega_0,\omega_2}(\mathbb{E}_{\omega_1}\Phi((a\omega_0 + b\sin(t)\omega_2) + b\cos(t)\omega_1)))\omega_1) \\ = \ & \frac{b\cos(t)}{\sqrt{1+b^2\cos^2(t)}}\mathbb{E}_{\omega_0,\omega_2}\phi(\frac{a\omega_0 + b\sin(t)\omega_2}{\sqrt{1+b^2\cos^2(t)}}) \\ = \ & \frac{b\cos(t)}{\sqrt{1+b^2}}\mathbb{E}_{\omega_0}\phi(\frac{a\omega_0}{\sqrt{1+b^2}}) \\ = \ & \frac{b\cos(t)}{\sqrt{1+b^2}}\frac{1}{\sqrt{1+\tilde{b}^2}}\phi(0) \\ = \ & \frac{1}{2}\cos(t)\phi(0). \end{aligned}$$

We now focus on the last term. We first integrate ω_2, then ω_1, and finally ω_0. Otherwise, the steps and properties we follow are identical to those from the second term.

$$\begin{aligned} & \mathbb{E}_\omega(\Phi(a\omega_0 + b(\cos(t)\omega_1 + \sin(t)\omega_2)))\omega_2) \\ = \ & \mathbb{E}_{\omega_0,\omega_1}(\mathbb{E}_{\omega_2}\Phi((a\omega_0 + b\sin(t)\omega_2) + b\cos(t)\omega_1)))\omega_2) \\ = \ & \frac{b\sin(t)}{\sqrt{1+b^2\sin^2(t)}}\mathbb{E}_{\omega_0,\omega_1}\phi(\frac{a\omega_0 + b\cos(t)\omega_1}{\sqrt{1+b^2\sin^2(t)}}) \\ = \ & \frac{b\sin(t)}{\sqrt{1+b^2}}\mathbb{E}_{\omega_0}\phi(\frac{a\omega_0}{\sqrt{1+b^2}}) \\ = \ & \frac{b\sin(t)}{\sqrt{1+b^2}}\frac{1}{\sqrt{1+\tilde{b}^2}}\phi(0) \\ = \ & \frac{1}{2}\sin(t)\phi(0). \end{aligned}$$

Putting all together, we have that

$$\begin{aligned} \lim_{N\to\infty}\mathcal{U}(N) &= \frac{I-1}{I}\mathbb{E}_{\omega,t_i,t_j}\Big(\Phi(\frac{1}{\sqrt{2}}u_j(\omega,t_j))u_i(\omega,t_i)\Big) + \bar{\mathcal{V}} \\ &= \frac{I-1}{I}\mathbb{E}_{t_j}(\frac{1}{2}\phi(0) + \frac{1}{2}\beta_F\phi(0)(\cos(t_j)\cos(t^m) + \sin(t_j)\sin(t^m)) + \bar{\mathcal{V}} \\ &= \frac{I-1}{I}\frac{1}{2}\phi(0)\mathbb{E}_{t_j}(1 + \beta_F\cos(t_j - t^m)) + \bar{\mathcal{V}} \\ &= \frac{I-1}{I}\frac{1}{2}\frac{1}{\sqrt{2\pi}}(1+\beta_F^2) + \lambda\sqrt{2} \\ &= \lambda(I-1)\frac{1}{\sqrt{2}}(1+\beta_F^2) + \lambda\sqrt{2}. \end{aligned}$$

For the fourth equality, we use the definition β_F. Moreover, we used the fact that $\bar{\mathcal{V}} = \lambda\sqrt{2}$ and $\phi(0) = \frac{1}{\sqrt{2\pi}}$. In passing, note that $\beta_F = 0$ if f is uniform. In such case, the value of $\lim_{N\to\infty}\mathcal{U}(N)$ matches the one computed in Equation A9.

(Comparsion Between Monopoly and Perfect Competition). We established that:

$$\mathcal{U}(1) - \lim_{N\to\infty}\mathcal{U}(N) = \lambda(I-1)\sqrt{1+\beta_F^2}\Big(1 - \sqrt{\frac{1+\beta_F^2}{2}}\Big) - \lambda\sqrt{2}$$

Note that for all non-degenerate distributions F, $\beta_F \in [0,1)$. Therefore, $1 > \sqrt{\frac{1+\beta_F^2}{2}}$. That is, for any distribution F, there exists a $\bar{I}$ such that, for all $I > \bar{I}$, $\mathcal{U}(1) > \lim_{N\to\infty}\mathcal{U}(N)$. That is, the ex-ante utility of a typical agent is higher when $N = 1$ than when $N \to \infty$. □

Remark B1. *Fix a regular F. For all N, the equilibrium editorial strategy of the monopolist maximizes $\mathcal{G}(N)$.*

Proof. Fix N. Let $(x_{n(i)}, t_{n(i)})$ denote the editorial strategy associated with the signal acquired by type t_i and $a^\star(\omega, t_i)$ denote the optimal approval decision for type t_i given the signal induced by $(x_{n(i)}, t_{n(i)})$.

$$\begin{aligned}
\mathcal{G}(N) &= \mathbb{E}_{(t_1,\ldots,t_I)}\Big(\mathbb{E}_\omega(A^\star_{-i}(\omega)u(\omega, t_i))\Big) \\
&= \mathbb{E}_\omega\Big(\tfrac{I-1}{I}\mathbb{E}_{t_j}(a^\star(\omega, t_j))(\omega_0 + \beta_F(\cos(t^m)\omega_1 + \sin(t^m)\omega_2))\Big) \\
&= \mathbb{E}_\omega\Big(\tfrac{I-1}{I}\mathbb{E}_{t_j}(\Phi\Big(\sqrt{x} + \sqrt{1-x}(\cos(t)\omega_1 + \sin(t)\omega_2)\Big))(\omega_0 + \beta_F(\cos(t^m)\omega_1 + \sin(t^m)\omega_2))\Big) \\
&= \tfrac{I-1}{I}\tfrac{1}{\sqrt{2}}\phi(0)\Big(\sqrt{x} + \sqrt{1-x}\beta_F\cos(t - t^m)\Big)
\end{aligned}$$

The second line is established Equation (B6) from the proof of Lemma B5. Suppose that each agent's approval decision depends on the sign of the signal she receives (to be confirmed below). If everyone follows the signal, then the optimal solution involves providing the same information structure to all agents. That is, the solution is independent of N. Therefore, the approval probability can written as a function of ω and a single editorial strategy (x, t). The last line follows from implementing the same steps of the second part (i.e. Perfect Competition, $N \to \infty$) of the proof of Lemma B5. Given this derivation, it is immediate to see that $\mathcal{G}(N)$ is maximized when $t = t^m$ and $x = (1 + \beta_F^2)^{-1}$. As shown in the first part (i.e. Monopoly, $N = 1$) of the proof of Lemma B5, this coincides with the equilibrium editorial strategy of the monopolist. To conclude, note that $x > 1/2$, since $\beta_F < 1$, which implies the signal induced is positively correlated with $u(\omega, t_i)$ for any t_i, confirming that all types would indeed vote according to the sign of the signal.

B.2. A Model of Multimedia

In the baseline version of the model, we assumed that agents can acquire at most one signal. This section discusses how to extend our main result to the case when agents can simultaneously acquire information from multiple firms. One obvious effect of increasing the number of competing firms—for example from $N = 1$ to $N = 2$—is that agents can acquire more signals. This can in principle affect the results of the paper. Indeed, if agents can process an unlimited number of signals at no cost and the price of these signals converges to zero with N, then agents could learn the state as the market becomes perfectly competitive.

While extending the main result to the multimedia case, we maintain the assumption that agents are constrained in how many signals they can acquire or process. In particular, we assume that each agent is endowed with a unit of time that she can divide among N firms. That is, agent i chooses $\alpha_i \in \Delta(N)$ and $\alpha_i(n)$ represents the fraction of time that agent i spends on the signal supplied by firm n. It is convenient to model firms' editorial strategies using the vector notation introduced in Section 2. In particular, firm n chooses $b_n \in \mathbb{R}^3$ such that $\|b_n\| \leq 1$. Fix a profile of editorial strategies $(b_1, \ldots, b_N)$ and suppose that agent i's information-acquisition strategy is α_i. We assume that agent i observes the realization from a mixture signal characterized by b_{α_i}, where for $b^k_{\alpha_i} = \sum_{n=1}^N \alpha_i(n) b_{n,k}$ for $k = \{0, 1, 2\}$.

$$s_i(\omega, b|\alpha_i) = \Big(\sum_{n=1}^{N} \alpha_i(n) b_n\Big) \cdot \omega + \varepsilon_i = b_{\alpha_i} \cdot \omega + \varepsilon_i. \tag{B7}$$

Note that when $\alpha_i \in \Delta(N)$ is degenerate, this reduces to our baseline model. Moreover, the value of information given α_i, denoted by $v(b_{\alpha_i}|t_i)$ is still characterized by Lemma 2.[19] Since ε_i does not scale with N, this formulation preserves a key feature of the baseline model, namely that the agent is constrained in how much she can learn about the state. At the same time, the ability to mix among multiple signals allows an agent to "construct" signals that are better tailored to her own needs.[20]

The main challenge in such a model is to determine how profits of the firms are linked to the value of information created for each agent and the competition in the market. To make the model tractable, we make a reduced-form assumption on how a firm's profit from an agent depends on the *surplus* generated by the firm for the agent, i.e. the difference between the agent's first-best value and the second-best value she could have obtained in the absence of this firm. Formally, given a profile of editorial strategies $b = (b_1, \dots, b_N)$, let $\alpha_i^b \in \arg\max_{\alpha_i} v(b_{\alpha_i}|t_i)$. We assume that firm n's revenue from agent t_i is

$$p_n(t_i|b) = \frac{1}{N}\Big(v(b_{\alpha_i^b}|t_i) - \max_{\alpha_i':\alpha_i'(n)=0} v(b_{\alpha_i'}|t_i)\Big). \tag{B8}$$

When α_i is degenerate, that is agent i acquires information from a single firm, then firm n's revenue is the same as in our baseline model, net of weight $\frac{1}{N}$.[21] Overall, a profile of editorial strategies b induces profits for firm n which are $\Pi_n(b_n, b_{-n}) = \int_T p_n(t_i|b) dF(t_i)$.

Agents choose α_i to maximize $v(b_{\alpha_i}|t_i) - \sum_{n:\alpha_i(n)>0} p_n(t_i|b)$. Once again, this reduces to the baseline model if α_i degenerate. Note that the solution of the agent's maximization problem, call it $\hat{\alpha}_i$, depends on α_i^b via $p_n(t_i|b)$. The following remark shows that $\hat{\alpha}_i = \alpha_i^b$. Therefore, we can interpret $p_n(t_i|b)$ as a price that the agent has to pay to firm n in order to acquire its signal.

Remark B2. *Fix t_i and a profile of editorial strategies b. Let $\alpha_i^\star \in \arg\max_{\alpha_i} v(b_{\alpha_i}|t_i)$. Then,*

$$\alpha_i^\star \in \arg\max_{\alpha_i} v(b_{\alpha_i}|t_i) - \sum_n \frac{1}{N}\Big(v(b_{\alpha_i^\star}|t_i) - \max_{\alpha_i':\alpha_i'(n)=0} v(b_{\alpha_i'}|t_i)\Big)$$

Proof of Remark B2. Fix t_i and a profile of editorial strategies b. Let $\hat{\alpha}_i \in \arg\max_{\alpha_i} v(b_{\alpha_i}|t_i)$. Define $p_n(t_i|b) = \hat{\alpha}_i(n)\big(v(b_{\hat{\alpha}_i}|t_i) - \max_{\alpha_i':\alpha_i'(n)=0} v(b_{\alpha_i'}|t_i)\big)$. We want to show that $\hat{\alpha}_i \in \arg\max_{\alpha_i} v(b_{\alpha_i}|t_i) -$

[19]Lemma 2 uses the notation of θ_i—instead of t_i as we do in this section—to denote an agent's type. Remark 1 establishes how one variable can be transformed into the other. For each t_i, there is an equivalent $\theta_i = (1, \cos(t_i), \sin(t_i))$.

[20]For example, suppose that $t_i = \pi/4$, $b_1 = (0, 1, 0)$, and $b_2 = (0, 0, 1)$. Fix $\alpha_i(1) = \alpha_i(2) = \frac{1}{2}$. Then $v(b_{\alpha_i}|t_i) > v(b_1|t_i) = v(b_2|t_i)$. That is, the agent does strictly better by mixing than by acquiring a single signal.

[21]The weight $\frac{1}{N}$ is useful normalization to avoid that the agent overpays for information when she acquires signals that are complement. As it is shown below, any weighting $(w_i(1|b), \dots, w_i(N|b))$ that possibly depends on i and b in a continuous manner would generate the same results.

$\sum_{n:\alpha_i(n)>0} p_n(t_i|b)$. Suppose not. Then, there is $\tilde{\alpha}_i \neq \hat{\alpha}_i$ such that

$$v(b_{\tilde{\alpha}_i}|t_i) - \sum_{n\,:\,\tilde{\alpha}_i(n)>0} p_n(t_i|b) > v(b_{\hat{\alpha}_i}|t_i) - \sum_{n\,:\,\hat{\alpha}_i(n)>0} p_n(t_i|b).$$

Let $\hat{N} = \{n : \hat{\alpha}_i(n) > 0\} \setminus \{n : \tilde{\alpha}_i(n) > 0\}$. Note that $\hat{N} \neq \emptyset$. Indeed, given that $\hat{\alpha}_i \in \arg\max_{\alpha_i} v(b_{\alpha_i}|t_i)$, $\hat{N} = \emptyset$ would contradict the existence of $\tilde{\alpha}_i$. Thus, we can rewrite the inequality above as:

$$v(b_{\hat{\alpha}_i}|t_i) - \max_{\alpha_i\,|\,\alpha_i(n)=0\ \forall n\in\hat{N}} v(b_{\alpha_i}|t_i) \leq v(b_{\hat{\alpha}_i}|t_i) - v(b_{\tilde{\alpha}}|t_i) < \sum_{n\in\hat{N}} p_n(t_i|b).$$

However, a contradiction is reached by noting that

$$\begin{aligned}
\sum_{n\in\hat{N}} p_n(t_i|b) &= \sum_{n'\in\hat{N}} \frac{1}{N}\Big(v(b_{\hat{\alpha}_i}|t_i) - \max_{\alpha_i\,|\,\alpha_{n'}=0} v(b_{\alpha_i}|t_i)\Big) \\
&\leq \sum_{n'\in\hat{N}} \frac{1}{N}\Big(v(b_{\hat{\alpha}_i}|t_i) - \max_{\alpha_i\,|\,\alpha_i(n)=0\ \forall n\in\hat{N}} v(b_{\alpha_i}|t_i)\Big) \\
&= \Big(v(b_{\hat{\alpha}_i}|t_i) - \max_{\alpha_i\,|\,\alpha_i(n)=0\ \forall n\in\hat{N}} v(b_{\alpha_i}|t_i)\Big)\Big(\sum_{n'\in\hat{N}} \frac{1}{N}\Big) \\
&\leq v(b_{\hat{\alpha}_i}|t_i) - \max_{\alpha_i\,|\,\alpha_i(n)=0\ \forall n\in\hat{N}} v(b_{\alpha_i}|t_i).
\end{aligned}$$

The first inequality holds since, for all $n' \in \hat{N}$, $\max_{\alpha_i}\{v(b_{\alpha_i}|t_i)|\alpha_i(n) = 0, \forall n \in \hat{N}\} \leq \max_{\alpha_i}\{v(b_{\alpha_i}|t_i)|\alpha_i(n') = 0\}$. The last inequality holds since $\sum_{n'\in\hat{N}} \frac{1}{N} \leq 1$. □

The next result argues that the results in Proposition 5 also holds in the multimedia model that we introduced above.

Claim 1 (Multimedia)**.** *Fix any regular distribution f. There exists $\bar{I}$ such that, for all $I > \bar{I}$, the ex-ante utility of a typical agent in the multimedia model is higher under monopoly than perfect competition. That is, $\mathcal{U}(1) > \lim_{N\to\infty} \mathcal{U}(N)$.*

The proof of this result mimics the one of Proposition 5. In the interest of space, we do not replicate such proof here, but rather briefly show how to adapt the arguments of its building blocks—namely Lemmas B1 to B5)—to the case of multimedia. In essence, the proof shows that, when $N = 1$ and when $N \to \infty$, the ex ante utility of a typical agent in both the baseline and the multimedia model are the same. Therefore, the same comparison of Proposition 5 holds for the multimedia model.

1. Game and Equilibrium Existence. First, we need to ensure equilibrium existence for arbitrary N. In the multimedia model outlined above, the timeline of the game is as in Figure 1, with the difference that prices are being set exogenously as a function of the chosen profile of editorial strategies b, as explained above. Using backward induction, we argue that an equilibrium of the game exists. Fix an arbitrary profile of *information-acquisition* strategies $(\alpha_1, \ldots, \alpha_I)$. Then, Lemma 1 still characterizes the agents' equilibrium *approval* decisions. Now consider an arbitrary profile of editorial strategies b and the profile prices $(p_n(t_i|b))_n$ that ensues. Agent t_i's equilibrium *information-acquisition* strategy consists of choosing α_i to maximize $v(b_{\alpha_i}|t_i) - \sum_{n:\alpha_i(n)>0} p_n(t_i|b)$. Note that $v(b_{\alpha_i}|t_i) - \sum_{n:\alpha_i(n)>0} p_n(t_i|b)$

is continuous in $\alpha_i \in \mathbb{R}^N$ and that $\Delta(N)$ is compact. Therefore, the agent's problem admits a solution. In the first stage of the game, firms simultaneously choose b_n. Their payoff function is $\Pi_n(b_n, b_{-n}) = \int_T p_n(t_i|b)dF(t_i) = \frac{1}{N}\int_T v(b_{\alpha_i^b}|t_i) - \max_{\alpha_i':\alpha_i'(n)=0} v(b_{\alpha_i'}|t_i)dF(t_i)$. Recall that $v(b_{\alpha_i^b}|t_i) = \max_{\alpha_i \in \Delta(N)} v(b_{\alpha_i}|t_i)$. With a standard application of the theorem of the maximum, it is easy to see that $v(b_{\alpha_i^b}|t_i)$ is continuous is b. By a similar argument, one can show that $\max_{\alpha_i':\alpha_i'(n)=0} v(b_{\alpha_i'}|t_i)$ is also continuous is b. Therefore, $\Pi_n(b_n, b_{-n})$ is continuous in b for all n. As in Lemma B1, we invoke Glicksberg's theorem to argue that, in the first stage of the game, a Nash Equilibrium exists in (possibly mixed) editorial strategies. By backward induction, we have shown that the game admits an equilibrium.

2. Convergence to Daily-Me in Expectation and Probability. Thanks to the modeling assumption of Equation (B7), we conveniently have that $\max_b \max_{\alpha_i} v(b_{\alpha_i}|t_i) = \bar{\mathcal{V}} = \lambda\sqrt{2}$. [22]. That is, the first-best value that an agent can achieve is $\bar{\mathcal{V}}$, the same value of our baseline model (e.g. see Remark 2 or Lemma B2). This facts allows us to closely follow the steps in the proof of Proposition 5. The first of such steps consists of showing that, as the number of competing firms increases, the value of information that each agent obtains in equilibrium converges, in expectation, to $\bar{\mathcal{V}}$. More formally, fix an agent t_i and an arbitrary sequence of equilibria. Denote by $\chi^N = (\chi_n)$ the profile of (possibly mixed) editorial strategies, with $\chi_n \in \Delta(\{b_n \in \mathbb{R}^3 : ||b_n|| \leq 1\})$. We want to show that for all $\delta > 0$, there exists a $\bar{N}$ such that for all $N > \bar{N}$, $\mathbb{E}_{\chi^N}(\max_\alpha v(b_\alpha|t_i)) > \bar{\mathcal{V}} - \delta$. To prove this, we follow the steps in the proof of Lemma B2. While we do not replicate the proof here, the proof assumes for contradiction that the result does not hold for some type $\bar{t}_i$ and $\delta > 0$. By continuity of $\max_{\alpha_j} v(b_{\alpha_j}|t_j)$ in t_j, there exists (1) $\xi_1 > 0$ such that, for all $t_j \in [\bar{t}_i - \xi_1, \bar{t}_i + \xi_1]$, $\mathbb{E}_{\chi^N}(\max_{\alpha_j} v(b_{\alpha_j}|t_j)) \leq \bar{\mathcal{V}} - \frac{\delta}{2}$ and (2) $\xi_2 > 0$ such that, for all $t_j \in [\bar{t}_i - \xi_2, \bar{t}_i + \xi_2]$ and given vector $b_{t_i} := \frac{1}{\sqrt{2}}(1, \cos(t_i), \sin(t_i))$, we have $v(b_{t_i}|t_j) \geq \bar{\mathcal{V}} - \frac{\delta}{4}$. Setting $\xi = \min\{\xi_1, \xi_2\}$, we show that for N large enough, there always is a firm for which it would be strictly profitable to deviate to b_{t_i}.

Building on the previous argument, we can show convergence in probability. More formally, fix t_i, $\epsilon > 0$, and a sequence of equilibria. For any N, denote by $b^N_{\alpha_i}$ the random variable specifying the information structure that agent t_i acquires in equilibrium. As above, let $b_{t_i} := \frac{1}{\sqrt{2}}(1, \cos(t_i), \sin(t_i))$, and note that $v(b_{t_i}|t_i) = \bar{\mathcal{V}}$. We want to show that, for all $\delta > 0$, there exists $\bar{N}$ such that for all $N > \bar{N}$, $Pr(||b^N_{\alpha_i} - b_{t_i}|| > \epsilon) < \delta$. To do this, we can follow exactly the same steps as in the proof of Lemma B3, where we replace $(x^N_{n(t_i)}, t^N_{n(t_i)})$ with $b^N_{\alpha_i}$ and $(1/2, t_i)$ with b_{t_i}.

3. Convergence of Ex Ante Utility. Note that, when $N = 1$, the agent's ex ante utility is unaffected by the introduction of multimedia. Therefore, $\mathcal{U}(1)$ is computed exactly as in Lemma B5. In particular, we still have that $\mathcal{U}(1) = (I - 1)\lambda\sqrt{1 + \beta_F}$. We now turn to the limit $\lim_{N\to\infty} \mathcal{U}(N)$. For any realization b of the (possibly mixed) equilibrium editorial strategies, the decomposition of the ex ante utility from Equation (B3) still holds in the multimedia model. Given Equation (B8), it is true by construction that $\lim_{N\to\infty} p_n(t_i|b) = 0$. Moreover, since $b^N_{\alpha_i}$ converges in probability to the first-best information structure

[22]This follows from Lemma A1 which establishes that the value of information is maximized for each agent (given constraints on firms' strategies) when $||b_{\alpha_i} = 1||$.

b_{t_i}, we have that the $v(b^N_{\alpha_i}|t_i)$ converges in probability to $\bar{\mathcal{V}}$. Given this, we can follow the steps in Lemma B4 and in the latter part of Lemma B5 to argue that $\lim_{N\to\infty} \mathcal{U}(N) = \lambda(I-1)\frac{1}{\sqrt{2}}(1+\beta_F) + \lambda\sqrt{2}$. That is, we argue that both when $N = 1$ and $N \to \infty$, the baseline model and the multimedia model generate ex ante utility that are identical. Given this, the statement of Claim 1 follows directly from Proposition 5.