

Ideological Screening with Content Provision

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May, 2025

Abstract

I recognize informational content as an endogenous presentation of evidence from a content provider to a unit mass of receivers with heterogeneous ideology. Through a content-providing contract, the provider screens the receiver's ideology with some content of various stances and credibility, which then shapes the posterior belief of the receiver. The characteristics of the optimal content provision depend on whether the receiver regards his ideology and the content as information substitutes or information complements. Content provision exhibits a screening property if they are regarded as information substitutes due to the tradeoff between affirmation and rent extraction. If they are considered information complements, content provision exhibits a bang-bang property due to the inconsistency between marginal value and willingness to pay for content. A tractable content-providing contract assuming a Bayesian receiver is examined. A receiver with a stronger ideology is induced to take a weakly less credible content of the same stance. As a corollary, the posterior belief exhibits polarization across stances but convergence within.

Keywords: ideological screening, informational content, freemium, belief polarization

JEL: D82, D83, D86

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1 Introduction

We resort to informational content, such as articles, podcasts, and advice, to acquire information on the state of the world. The credibility of content on the same issue can be vastly diverse and endogenously determined by the content provider. For instance, regarding the value of diversity in university education and inclusive employment at work, content with statistical evidence on how the overall performance of students during and after graduation relate to diversity on campus or statistical evidence on how worker performances relate to an inclusive corporate culture generally tells a more credible story than does content that quotes “an anonymous source.” Whether to present statistical evidence or merely a quote from an anonymous source in the content is an endogenous choice of the content provider. On the demand side, content receivers have heterogeneous ideologies and affirmational demands for information. The latter arises from the preference to refine the content receiver’s prior beliefs upon processing the full content.¹ When providing content to a mass of content receivers with affirmational demand and privately known prior ideologies, the credibility of content serves as a screening device. Applying a contract theoretical approach, I characterize the optimal content provision to screen the receivers’ prior ideologies. Specifically, what is the fundamental tradeoff behind the provider’s choice of content, and how does it relate to how the receivers process information? In addition to screening the receivers’ prior ideologies, the content also shapes their updated beliefs. Would the optimal content provision induce congruent beliefs, or would it exacerbate the disagreement among the receivers?

Consider a content provider endowed with a rich set of raw evidence to be presented as content to a unit mass of readers (content receivers). For example, on the issue of diversity on campus and inclusive employment at work, the raw evidence includes administrative data on underprivileged minorities, inclusive employment of people with disabilities, diversity in the student body of universities, performance of workers and students, etc. The readers differ in ideologies, modeled as prior beliefs about the state of the world, e.g., whether diversity and inclusion are valuable. These ideologies are private information to the readers. A reader demands content that shapes his posterior belief regarding the state, given which he makes a non-contractible action choice, e.g., whether to support an inclusive policy or against it. The provider decides what

¹While some demands for information are instrumental, some are indeed affirmational. Please refer to the experimental evidence on the preference for non-instrumental information in Eliaz and Schotter (2007, 2010) and on the avoidance of useful information in Golman, Hagmann, and Loewenstein (2017).

evidence to present and how to present the evidence in the content. This presentation of evidence determines the stance of the content as well as its credibility. Such stance and credibility can be committed through the abstract of the content. The provider proposes a content-providing contract as a menu of options, each consisting of credibility and stance of the full content committed through the abstract and associated payment. If the reader accepts the contract, he chooses an option in the menu and receives the full content. For instance, regarding the issue of diversity on campus, the content-providing contract can include three options. One option is simply an article for free with a moral statement that basic human rights should be protected; another option includes an article with statistical evidence on a positive relationship between diversity on campus and student performance at a price for the detailed statistical analysis; the other option includes an article with an interview of a named professor who suggested formal equality in college admission at a price for the full interview. The reader of the content anticipates how his posterior belief will be updated upon choosing an option in the contract, and his posterior belief is updated after receiving the full content. The content screens the reader's prior ideology and shapes his posterior belief.

The reader's net value of content stems from the affirmation about the state after receiving the content and depends on his prior ideology. If the most credible content is provided to the readers, the net value of content is the highest for the provider to extract. Readers with heterogeneous ideologies, however, disagree on such values. A reader of a stronger ideology (e.g., who strongly supports or goes against diversity on campus) has a lower net value of the credible content and, hence, a lower willingness to pay for the content. Screening the reader's ideology thus relies on the distortion of content credibility, which implements a lower level of affirmation. The optimal content-providing contract exhibits a tradeoff between affirmation and rent extraction.

How such a tradeoff shapes the optimal content-providing contract depends on how the readers process information, specifically, whether the readers regard their prior ideologies and the content as information substitutes or information complements. The content is an information substitute to the prior ideology if a reader with a stronger ideology updates his belief with a smaller magnitude upon receiving more credible content of the same stance. Bayesian belief is one example. The content and the prior ideology are information complements if otherwise.

If the content and the prior ideology are information complements, a reader with a stronger ideology expects a larger marginal value on the credibility of content supporting a given stance, but he is willing to pay less for the content. With these coun-

tervailing incentives, the optimal content-providing contract has a bang-bang property with three options: fully credible content of each stance at a fixed price and neutral content (which does not update belief) for free. Readers with extreme ideologies are induced to take the free neutral content, while those with intermediate ideologies take the fully credible content supporting the same stance as their prior ideology. Revisit the example regarding diversity on campus. If the readers regard content and their prior ideologies as information complements, the optimal contract would include a priced option of highly credible content supporting campus diversity, one that holds the opposite view with the same level of credibility, and a free option with only a neutral statement.

A more sophisticated screening is feasible when the content and the prior ideology are information substitutes. A reader with a stronger ideology resembles the “less efficient type” in traditional screening problems. He expects a lower marginal value on the credibility of content and is willing to pay less for the content. The optimal content-providing contract thus exhibits a screening property: decreasing credibility of content supporting each stance at a decreasing price for a reader who reveals a stronger ideology. Readers with more extreme ideologies are induced to take the less credible content at lower prices, while those with relatively intermediate ideologies take the more credible content at higher prices.

A tractable solution to the optimal content-providing contract can be found with Bayesian beliefs. Readers with Bayesian beliefs regard the content and their prior ideologies as information substitutes. The reader with a neutral prior ideology resembles the “most efficient type” in traditional screening problems. The optimal content-providing contract is symmetric and exhibits decreasing credibility of content supporting each stance for a reader who reveals a stronger ideology. The ex-ante neutral reader is indifferent between the fully credible content of each stance at the highest price. Readers with relatively intermediate ideologies are induced to take the more credible content of the same stance at higher prices, while readers with sufficiently extreme ideologies are induced to take the neutral content for free.

This optimal contract exhibits the property of freemium: basic content for free and options for in-depth analysis at higher prices. Differentiated content is not only provided across providers but also within the same provider. There are several ways to practically implement freemium. Each piece of content is partially free, and its full content is available at a price. We can also view content as a series of articles. Free limited access to only a few of them provides less credible information than complete access to all of them at a price. The in-depth analysis can also take the form of

paid-member-only materials with more details of relevant issues. Screening for profit is proposed as an explanation for the differentiated content. Revisit the example regarding diversity on campus. If the readers regard content and their prior ideologies as information substitutes, the optimal contract would include several options, some supporting campus diversity while some against it. Among those supporting (respectively, against) campus diversity, some options include more in-depth analysis or more articles at a higher price, while some include only a limited amount of basic articles at a lower price.

A reader under the optimal contract is induced to take an option that conforms to his prior ideology. Given Bayesian updating, he is more assured about the state of the world after reading the full content. Since a reader with a relatively neutral prior ideology is induced to take the content with higher credibility, his posterior belief is affected by the content to a greater extent. The posterior beliefs of the readers thus exhibit polarization across stances but convergence within each stance to a more assured belief. The readers' posterior beliefs eventually form two opposing and more solid echo chambers after reading the full content. Those who originally supported (respectively, went against) campus diversity weakly affirm their ideologies with content of non-increasing credibility. Consensus on the issue would not be reached in equilibrium.

1.1 Literature

Content as a source of information, the paper is most related to contracting for information products with privately known prior beliefs.² Modeling information products as experiments, Bergemann, Bonatti, and Smolin (2018) characterize the optimal contract on experiments that generate signals regarding the true state of nature, with asymmetric information on the agent's prior information. With binary prior, it is optimal to provide a fully informative experiment for the less priorly informed type and a partially informative experiment for the better priorly informed type of agent. With continuous prior, the optimal experiment is a step function with some pooling, prescribing a fully informative experiment for the agent with intermediate prior beliefs and a non-informative experiment for the agent with extreme prior beliefs. Not only are economists interested in contracting for data/experiments, but it is also a rising

²This belongs to a broader category of literature on trading information/data, e.g., Taylor (2004), Bergemann and Bonatti (2015), Kastl, Pagnozzi, and Piccolo (2018), and references therein. In these papers, the trading partners do not have asymmetric information except the piece of information being traded.

topic in information science. Babaioff, Kleinberg, and Leme (2012), Chen, Xu, and Zheng (2020), and Liu, Shen, and Xu (2021) are among the recent studies on data selling mechanisms. The former two show that the optimal mechanism can be computed in polynomial time, and it resembles a consulting mechanism; the latter characterizes a closed-form solution. On the other hand, Eső and Szentes (2007) study the consulting contract between a consultant (advice provider) and a client, with asymmetric information on how the client evaluates the advice. The optimal contract specifies a probability for the consultant to check the signal of the real state. They show an equivalence result regardless of whether the consultant perfectly or imperfectly observes the signal.

Content in the current context resembles experiments/advice in the above literature in the sense that these “information products” have a quality (here, credibility) and positioning (here, stance) dimension, unlike usual physical goods. The fundamental difference between content provision and data/information provision lies in the following. It is the experiment (or the adviser’s action to check the signal) that is being contracted in the above research. Signal realizes after the contract is signed, and the agent updates his belief and takes action based on the realization of signals. The experiment designer (or adviser) commits to the accuracy of the signal-generating experiment instead of the realization of signals. Ex-ante upon contracting, the agent anticipates how informative regarding the true state he will be after the experiment. The value of the experiment comes from its informativeness. In the current context, the content provider is endowed with some raw evidence (signals) before contracting. It is the presentation of the evidence that is being contracted. The agent’s updated belief and action depend on the content presented to him in the contract. The content provider commits to the credibility of the presented content instead of the correlation between the presented evidence and the true state. Upon contracting, the agent anticipates how his posterior belief will be updated after reading the full content. The value of the content comes from a more affirmative belief it induces. Implications of belief polarization can be drawn.³

Content provision can be regarded as a form of information disclosure, among others, such as advice or opinions. In the context of information disclosure, Krishna and Morgan (2008) and Hart, Kremer, and Perry (2017) focused on the commitment to disclosure. In Krishna and Morgan (2008), different levels of commitment to advice bridged cheap talk and screening in a unified model of communication. Hart, Kremer,

³Technicality-wise, the agent’s payoff in the former is linear in the experiment given Bayesian belief. In contrast, in the current model, it is generally non-linear in the content, even under Bayesian belief.

and Perry (2017) showed that commitment to rewards does not induce more disclosure of evidence. Given competition among heterogeneous information senders, Che and Kartik (2009) and Fischer, Heinle, and Smith (2020) studied how information receivers choose among senders. Che and Kartik (2009) showed that the optimality of selecting an advisor with a different opinion exhibits the tradeoff of strategic information acquisition and strategic disclosure. Fischer, Heinle, and Smith (2020) found better communication between a sender and a receiver when their preferences are more aligned, so receivers tend to voluntarily match with a like-minded sender. Two competing senders and greater polarization in receivers’ preferences thus lead to more equilibrium communication. More generally, Bertomeu and Cianciaruso (2017) proposed a unified framework of verifiable disclosure and showed a unique reasonable equilibrium in a similar spirit to the intuitive criterion. They characterized whether the information sender is better off or worse off with conditional and unconditional restriction of disclosure. In this strand of literature, there is no asymmetric information beyond the opinions, advice, or evidence to be disclosed. Disclosure itself is not a screening device. In the current model, content serves a duo role of transmitting information and screening the receivers’ ideologies.

Characterization of content that screens the agent’s prior belief and shapes the posterior belief, the paper shares a similar interest with the literature on belief polarization, e.g., Suen (2004), Benôit and Dubra (2019), Gentzkow, Wong, and Zhang (2021), and Kartik, Lee, and Suen (2021). These papers mainly focus on how the agent chooses his source of information or how the agents process or interpret the same piece of information differently, which leads to ex-post belief polarization. They focus on the demand side of information. I emphasize the design of content that screens the prior ideology and shapes the posterior belief, i.e., the supply-side story. With Bayesian belief, implication on belief polarization sustains across stance, while belief convergence is present within stance.

One straightforward application of content provision is the production of news. This paper is related to the active research on media bias and ideological segregation, e.g., the seminal work of Gentzkow and Shapiro (2006), Gentzkow and Shapiro (2010) on the driving force of media slant, Gentzkow and Shapiro (2011) on ideological segregation online and offline, Mullainathan and Shleifer (2005) on media competition through extreme slanting, and Bakshy, Messing, and Adamic (2015) on diverse choices of news and opinions on social media. These papers analyze media bias or slant at the level of news outlets. In this paper, I study further the differentiation among content provided by the same outlet. With the improving technique of automated content

analysis, the theoretical propositions in this paper are refutable.⁴

Modeling ideology as heterogeneous prior beliefs on the true state, this paper is also related to the literature with uncommon prior, with different research questions. To list a few, Yildiz (2003) studies bargaining with uncommon prior regarding the order of proposal; Eliaz and Spiegler (2006) studies exploitative contract to screen diversely naive consumers, modeling naivete as uncommon prior; Sandroni and Squintani (2007) studies insurance contract when the insuree has biased belief on his level of risk; Eliaz and Spiegler (2008) and Grubb (2009) study price discrimination with over-confident consumers.

Endogenous content provision may seem related to the literature on information design pioneered by Kamenica and Gentzkow (2011). Bergemann and Morris (2019) thoroughly review the literature in a unified framework. Recently, Kolotilin, Mylovanov, Zapechelnyuk, and Li (2017) and Min (2021) have incorporated screening into the persuasion mechanism. The content provider in this paper differs from the information designer in the sense that she does not derive utility directly from the true state or the content receiver’s action. Conceptually, the content provider has no inherent incentive to “persuade” the receiver. The research questions are different. These papers are devoted to studying the optimal information mechanism to influence the receiver’s behavior, whereas I focus on the optimal content provision to screen the receiver with heterogeneous prior ideology and how such content shapes the posterior belief of the receiver.

2 Model

The unknown future state of the world can be one with a new regime or one where the status quo remains, indexed as states ω_1 and ω_0 , respectively. A content provider (principal) is endowed with a rich set of raw evidence on the future state of the world, some pieces of evidence in favor of each state. She is to form a contractual relationship with a unit mass of independent readers (agents) to deliver content regarding the future state of the world.⁵ The reader’s intrinsic ideology is modeled as a privately known prior belief of the state that with probability $\phi \in [0, 1]$, the world will be in a new regime. The probability distribution of the ideologies, denoted as $F(\phi)$, is common

⁴Hamborg, Donnay, and Gipp (2019) surveyed some computer science techniques applied to study media bias and proposed directions for further research.

⁵The content is not restricted to written articles; it also includes videos, podcasts, and other formats that provide manipulated information. The readers can be any form of content consumers. I abuse the term reading just for ease of expression.

knowledge. The readers have no direct access to the raw evidence, which remains a neutral signal until delivered as content. The readers do not update their beliefs simply from the composition of the raw evidence.⁶ Upon reading the content provided, a reader updates his belief from his intrinsic ideology and takes a non-contractible action $a \in \{0, 1\}$ before the future state is realized. The action will generate one unit of value to the reader if action 0 is taken when the status quo remains or if action 1 is taken when the world has a new regime, with zero value otherwise. The content provider has no direct interest in the realization of the state or the reader’s action.

The content provider is able to choose what and how to present the evidence on the new regime in the content. The presented evidence is an objective signal independent of ideology, indicating a prior belief that with probability $q \in [0, 1]$, its prediction of the new regime is correct. We can interpret this belief as both the stance of the content and its credibility. A sufficiently small q implies more credible content favoring the status quo, while a sufficiently high q implies more credible content indicative of the new regime.⁷ For example, detailed content with some statistical analysis in favor of the new regime is of higher credibility than a quote from “an anonymous source” of the same stance. For another example, the content provider can quote experts from a conservative or a liberal think tank to develop content of different stances at comparable credibility.⁸ This setup of stance and credibility of content implies that the readers have a consensus on what content exhibits credibility q . Let the stance and credibility of the content q be contractible through an abstract of the full content along with an associated transfer t from the reader to the content provider.⁹ For instance, the provider can commit in the abstract that the full content will include an analysis using data collected by a specific think tank. Upon contracting, the reader can infer from the abstract the stance and credibility of the content.

⁶Alternatively, the intrinsic ideology can be viewed as an interim belief updated from the known composition of the provider’s raw evidence. While an entire ideological space is considered here, the model can be easily restricted to capture a narrower ideological space of a biased content provider’s readership.

⁷With binary states, evidence on the new regime with a very small probability of being correct is equivalent to evidence on the status quo with a very high probability of being correct. It is modeling equivalent to assume that the provider provides evidence on the status quo that is correct with probability $1 - q$.

⁸We do not explicitly model the process to present the evidence. One classic application is in news production by media outlets. Hamborg, Donnay, and Gipp (2019) provide comprehensive documentation on the production of news stories and the methods media outlets apply to shape the resulting news stories at every stage.

⁹I focus on paid content here. These can be found in paid articles following an abstract, online videos available only to paid members, etc. For free content sponsored by ads, please refer to Mitchell (2021) on equilibrium content as a reap and sow cycle of free advice and reward-earning advertisement.

Upon reading the full content of credibility q , a reader of ideology ϕ updates his belief in an organized and systematic fashion, captured by the posterior belief that with probability $\sigma(\phi, q)$, the world will be in a new regime. For ease of expression, define the content such that the reader of any ideology does not change his belief upon reading the full content as the “commonly recognized neutral content,” denoted as $\tilde{q}$ such that $\sigma(\phi, \tilde{q}) \equiv \phi$. For instance, if the reader updates his belief à la Bayesian, his belief after reading the content is $\sigma(\phi, q) = \frac{\phi \cdot q}{\phi \cdot q + (1-\phi) \cdot (1-q)}$, with $\tilde{q} = \frac{1}{2}$. Assumption 1 on the belief-updating process is made throughout the paper.

Assumption 1. *The reader’s posterior belief $\sigma(\phi, q) \in [0, 1]$ is such that*

1. *There is some commonly recognized neutral content.*
2. *The posterior belief $\sigma(\phi, q)$ is increasing in q at any ϕ .*
3. *The posterior belief $\sigma(\phi, q)$ is increasing in ϕ at any q .*

The first assumption implies that the readers have a consensus on what a neutral stance is. Along with the second assumption, it implies that any $q > \tilde{q}$ indicates a stance closer to the new regime, and it is more credible with a higher q ; symmetrically, any $q < \tilde{q}$ indicates a stance closer to the status quo, and it is more credible with a lower q . The third assumption implies that readers of different ideologies reading the same content do not update their beliefs in contrast to their prior ideologies. Reading the same content, a reader with an ideology closer to the new regime has an updated belief closer to the new regime. Bayesian belief satisfies Assumption 1 with $\tilde{q} = \frac{1}{2}$.

To focus on how the content screens the intrinsic ideology and shapes the posterior belief, I assume that the cost of content provision is sufficiently small and independent of the stance and credibility of content, normalized to zero. One can consider that the cost of raw material collection has been sunk when the content provider decides what evidence to present in the content. This zero-cost assumption implies an extreme benchmark with a commonly known prior belief ϕ : it is optimal to provide the most credible content in favor of the status quo ($q = 0$) or that indicative of the new regime ($q = 1$) to the reader of any ideology at his maximum willingness to pay for such extreme content.

Given a contract with content q and transfer t , the content provider’s payoff is given by $\pi(q, t) = t$. The content provider is purely for-profit. Without an intrinsic preference for the realization of the future state or for the reader’s action, the chosen content does not reflect the provider’s ideology. The reader’s expected payoff with

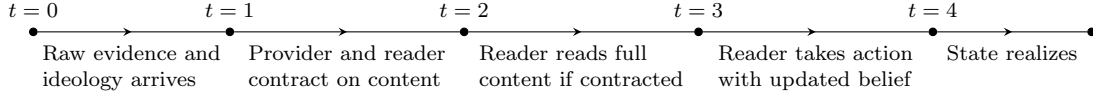


Figure 1: Timeline

updated belief $\sigma(\phi, q)$ before the choice of action is given by $u(q, t, a|\phi) = \sigma(\phi, q) \cdot \mathbf{1}_1 + (1 - \sigma(\phi, q)) \cdot \mathbf{1}_0 - t$, with $\mathbf{1}_a$ being an indicator function on future payoff at action $a \in \{0, 1\}$. Without signing the content-providing contract, the content provider earns a zero reservation payoff. The reader has no other source of information and chooses his action based on his intrinsic ideology. The reader's expected payoff with his prior belief before the choice of action is given by $v(a|\phi) = \phi \cdot \mathbf{1}_1 + (1 - \phi) \cdot \mathbf{1}_0$. The payoff expressions indicate that we focus on an affirmational demand for content instead of an instrumental one. The readers have a consensus on the content credibility, but they disagree on the value of the same credibility due to different ideologies and, hence, have different demands for content.¹⁰

With asymmetric information on ideology and commitment to the credibility of content, the content-providing contract consists of options to screen the reader's ideology. By the revelation principle, denote the contract as a direct revelation mechanism $\mathbb{C} = \{(q(\hat{\phi}), t(\hat{\phi}))\}$, where $\hat{\phi}$ is the revealed ideology.¹¹ The content provider designs the contract to induce the reader to truthfully reveal his ideology such that $\hat{\phi} = \phi$ in equilibrium.

The timeline of the game is given as follows and in Figure 1. The content provider is endowed with some raw evidence, and the reader is informed of his ideology before the contract proposal. The content provider proposes the take-it-or-leave-it contract $\mathbb{C}$, which is the only contract they can sign. The reader accepts or rejects the contract. If the reader accepts the contract, he chooses an option in $\mathbb{C}$ following his acceptance. Payment $t(\hat{\phi})$ is made, and the reader reads the full content of stance and credibility $q(\hat{\phi})$. After reading, the reader's belief $\sigma(\phi, q(\hat{\phi}))$ is updated based on his ideology and the chosen content. If the reader rejects the contract, his belief remains at his prior; no other content is available. After contracting for content (or not), the reader chooses an expected payoff maximizing action based on his updated belief. Upon reading the

¹⁰The affirmational demand of content arises when readers have intrinsic preferences for information that refines their beliefs, even if it does not change their ultimate decisions. This is in line with the experimental evidence on the preference for non-instrumental information in Eliaz and Schotter (2007, 2010) and on the avoidance of useful information in Golman, Hagmann, and Loewenstein (2017).

¹¹For technical and expositional convenience, I characterized the optimal content-providing contract with a continuum of options. The qualitative features we found resemble those in a less complex content-providing contract in practice, as discussed in Section 4.

full content, the reader takes $a = 1$ if $\sigma(\phi, q(\hat{\phi})) \geq 1 - \sigma(\phi, q(\hat{\phi}))$ and action $a = 0$ if otherwise. His expected payoff from the option $(q(\hat{\phi}), t(\hat{\phi}))$ is $u(q(\hat{\phi}), t(\hat{\phi})|\phi) \stackrel{\text{def}}{=} \max\{\sigma(\phi, q(\hat{\phi})), 1 - \sigma(\phi, q(\hat{\phi}))\} - t(\hat{\phi})$. Without contracting for content, the reader takes action $a = 1$ if $\phi \geq 1 - \phi$ and action $a = 0$ if otherwise. His expected payoff based on his ideology is $v(\phi) \stackrel{\text{def}}{=} \max\{\phi, 1 - \phi\}$. The state of the world and the actual payoff are realized afterward.

3 Content-Providing Contracts

The reader is willing to accept the content-providing contract given truthful revelation if the expected payoff based on the updated belief is higher than the expected payoff based on the prior belief, i.e., if the following individual rationality constraints hold for all ideology types,

$$u(\phi) \stackrel{\text{def}}{=} \max\{\sigma(\phi, q(\phi)), 1 - \sigma(\phi, q(\phi))\} - t(\phi) \geq \max\{\phi, 1 - \phi\} \quad \forall \phi.$$

The reader has incentive to reveal his true ideology if truthful revelation is expected payoff maximizing, i.e., if the following incentive compatibility constraints hold for all ideology types,

$$u(\phi) \geq \max\{\sigma(\phi, q(\hat{\phi})), 1 - \sigma(\phi, q(\hat{\phi}))\} - t(\hat{\phi}) \quad \forall \phi, \hat{\phi}.$$

The content provider's contracting problem is to maximize her expected payoff subject to the above individual rationality and incentive compatibility constraints, i.e.,

$$\max_{\mathbb{C}} \int_0^1 [t(\phi)] dF(\phi)$$

subject to $u(\phi) \geq v(\phi)$ and $u(\phi) \geq u(q(\hat{\phi}), t(\hat{\phi})|\phi)$ for all $\phi \in [0, 1]$.

For explanatory clarity, denote the options in the contract that induce $\sigma(\phi, q(\phi)) > 1 - \sigma(\phi, q(\phi))$ as $\{(q_1(\phi), t_1(\phi))\}$ and the options that induce $1 - \sigma(\phi, q(\phi)) > \sigma(\phi, q(\phi))$ as $\{(q_0(\phi), t_0(\phi))\}$. The former can be interpreted as content credibly supporting the new regime, while the latter can be interpreted as content credibly supporting the status quo. Expected payoffs implemented by the contract are denoted as $u_1(\phi) \stackrel{\text{def}}{=} \sigma(\phi, q_1(\phi)) - t_1(\phi)$ and $u_0(\phi) \stackrel{\text{def}}{=} 1 - \sigma(\phi, q_0(\phi)) - t_0(\phi)$ respectively. A reader with prior ideology $\tilde{\phi}$ is said to be ex-post indifferent (after reading the full content but before the realization of the true state) between $(q_1(\tilde{\phi}), t_1(\tilde{\phi}))$ and $(q_0(\tilde{\phi}), t_0(\tilde{\phi}))$ if $u_1(\tilde{\phi}) = u_0(\tilde{\phi})$.

Characteristics of an incentive compatible content-providing contract depend on whether the reader regards the content as a substitute or a complement to his prior ideology in information provision.

Definition 1. The reader regards the content as an information substitute to his prior ideology if $\frac{\partial^2 \sigma(\phi, q_1)}{\partial q_1 \partial \phi} < 0$ and $\frac{\partial^2 (1 - \sigma(\phi, q_0))}{\partial q_0 \partial \phi} < 0$. Ideology and content are regarded as information complements if $\frac{\partial^2 \sigma(\phi, q_1)}{\partial q_1 \partial \phi} > 0$ and $\frac{\partial^2 (1 - \sigma(\phi, q_0))}{\partial q_0 \partial \phi} > 0$.

The content is an information substitute (respectively, an information complement) to the reader's ideology if improved credibility of the content of a given stance updates the beliefs in a smaller magnitude (respectively, a larger magnitude) for readers with a more extreme ideology. Given information substitutes (respectively, information complements), a reader with a stronger ideology is less sensitive (respectively, more sensitive) to the content than one with a less extreme ideology.¹² Satisfaction of either information substitutes or information complements coincides with the single-crossing property assumed in traditional screening. Conversely, the single-crossing property in the current context is captured by a consistent way that the reader processes additional information.

Lemma 1. *If ideology and content are information substitutes, an incentive compatible content-providing contract is such that $q'_i(\phi) \leq 0$ for $i = 0, 1$ and $t'_1(\phi) \leq 0 \leq t'_0(\phi)$. If ideology and content are information complements, an incentive compatible content-providing contract is such that $q'_i(\phi) \geq 0$ for $i = 0, 1$ and $t'_1(\phi) \geq 0 \geq t'_0(\phi)$.*

Proof. Appendix A1. □

Define the net value of content as the difference between posterior belief and prior ideology, $\max\{\sigma(\phi, q(\phi)), 1 - \sigma(\phi, q(\phi))\} - \max\{\phi, 1 - \phi\}$. If prior ideology and content are information substitutes, a reader with a stronger ideology has a smaller marginal value of content supporting a given stance. For a reader who is induced to take the content credibly supporting the new regime (respectively, the status quo), his marginal willingness to pay for the more credible content is lower if he has a stronger prior belief of the new regime (respectively, the status quo). The incentive compatible contract thus has non-increasing credibility and transfers in stronger ideological types. If prior ideology and content are information complements, a reader with a stronger ideology

¹²Definition 1 is similar in spirit to Börgers, Hernando-Veciana, and Krämer (2013) and Chen and Waggoner (2016) in terms of whether an additional signal reduces or raises the marginal value of information with respect to the other. Chen and Waggoner (2016) look at a different research problem. The definition of Börgers, Hernando-Veciana, and Krämer (2013) can be related to the optimal content provision in this paper. I will postpone the discussion regarding this.

has a larger marginal value of content supporting a given stance. For a reader who is induced to take the content credibly supporting the new regime (respectively, the status quo), his marginal willingness to pay for the more credible content is higher¹³ if he has a stronger prior belief of the new regime (respectively, the status quo). The incentive compatible contract thus has non-decreasing credibility and transfers in stronger ideological types.

A reader with a stronger prior ideology has a higher expected payoff without the content and, hence, a lower net value of content. He is willing to pay less for the content of any credibility. To the extreme, a reader who is absolutely certain about the new regime or the status quo is unwilling to pay a positive transfer for any content. The profit-maximizing content provider thus provides the commonly recognized neutral content for free to at least the most extreme ideological types of readers.

Lemma 2. *The optimal content-providing contract satisfies binding individual rationalities for at least the readers with the most extreme ideologies $\phi = 1$ and $\phi = 0$.¹⁴*

Proof. Appendix A2. □

For a reader with an ideology closer to the new regime (status quo) than the ex-post indifferent type, the optimal contract implements the posterior belief towards the new regime (status quo). Relative to the ex-post indifferent type, the optimal contract provides content reaffirming the reader's belief.

Lemma 3. *It is not optimal for the content provider to induce the reader of prior ideology $\phi > \tilde{\phi}$ to take $\{(q_0(\phi), t_0(\phi))\}$ and the reader of ideology $\phi < \tilde{\phi}$ to take $\{(q_1(\phi), t_1(\phi))\}$. The optimal contract must not have $q_0(\phi) > \tilde{q}$ or $q_1(\phi) < \tilde{q}$.*

Proof. Appendix A3. □

By the envelope theorem of the reader's truthful revelation, $u'_1(\phi) = \frac{\partial \sigma(\phi, q_1(\phi))}{\partial \phi} > 0$ and $u'_0(\phi) = \frac{\partial (1 - \sigma(\phi, q_0(\phi)))}{\partial \phi} < 0$, incentive compatible contract implements a higher expected payoff for a reader whose prior ideology is closer to the implemented stance. To implement the updated belief towards the status quo for a reader with an ideology closer to the new regime than the ex-post indifferent type, it takes a negative transfer to satisfy incentive compatibility. The content provider can be better off by providing the commonly recognized neutral content for free, which is incentive feasible by construction, to avoid the negative transfer.

¹³His total willingness to pay for the content is lower, however, given a lower net value of content.

¹⁴For general contracting with type-dependent participation constraints, please refer to Lewis and Sappington (1989), Maggi and Rodríguez-Clare (1995), and Jullien (2000).

Given Assumption 1, if a content that is closer to the new regime than the commonly recognized neutral content but credibly suggests the status quo to a reader of type $\phi < \tilde{\phi}$, i.e., $q_0(\phi) > \tilde{q}$, this content reduces the reader's updated belief of the status quo from his prior ideology. The reader is willing to take this less valuable content only if it is at a negative transfer, which is not optimal for the content provider. The content provider can be better off proposing the commonly recognized neutral content at zero transfer for these types of readers instead, which is inherently incentive feasible. Symmetric reasoning holds for the suboptimality of $q_1(\phi) < \tilde{q}$.

Given the above three lemmas, the implemented payoff has $u_1(\phi) = 1 - \int_{\phi}^1 \frac{\partial \sigma(x, q_1(x))}{\partial x} dx$ for $\phi \geq \tilde{\phi}$ and $u_0(\phi) = 1 + \int_0^{\phi} \frac{\partial(1 - \sigma(x, q_0(x)))}{\partial x} dx$ for $\phi \leq \tilde{\phi}$. By definition of ex-post indifference, $u_1(\tilde{\phi}) = u_0(\tilde{\phi})$ implies $\int_{\tilde{\phi}}^1 \frac{\partial \sigma(\phi, q_1(\phi))}{\partial \phi} d\phi + \int_0^{\tilde{\phi}} \frac{\partial(1 - \sigma(\phi, q_0(\phi)))}{\partial \phi} d\phi = 0$. The reduced contracting problem for the content provider is

$$\begin{aligned} \max_{q(\phi), \tilde{\phi}} \int_0^1 \mathbf{1}_{\phi \geq \tilde{\phi}} \cdot & \left(\underbrace{\sigma(\phi, q_1(\phi))}_{\text{Affirmation}} - \underbrace{\left(1 - \frac{F(\phi) - F(\tilde{\phi})}{f(\phi)} \cdot \frac{\partial \sigma(\phi, q_1(\phi))}{\partial \phi} \right)}_{\text{Rent Extraction}} \right) \\ & + \mathbf{1}_{\phi \leq \tilde{\phi}} \cdot \left(\underbrace{1 - \sigma(\phi, q_0(\phi))}_{\text{Affirmation}} - \underbrace{\left(1 + \frac{F(\tilde{\phi}) - F(\phi)}{f(\phi)} \cdot \frac{\partial(1 - \sigma(\phi, q_0(\phi)))}{\partial \phi} \right)}_{\text{Rent Extraction}} \right) dF(\phi) \end{aligned}$$

subject to $q_1(\phi) \in [\tilde{q}, 1]$, $q_0(\phi) \in [0, \tilde{q}]$, and $q'_i(\phi) \leq 0$ for $i = 0, 1$ if ideology and content are information substitutes or $q'_i(\phi) \geq 0$ if ideology and content are information complements.

Noticeable from the reduced contracting problem, the content provider faces a tradeoff between affirmation and rent extraction. The reader's expected payoff maximization and risk neutrality imply the preference for affirmation over uncertainty. The willingness to pay for the most credible content is the highest as it affirms a reader's posterior belief. However, such willingness to pay differs across readers of different ideologies, whose posterior beliefs are updated to a different extent relative to their priors. Reducing content credibility to the reader of a stronger ideology, who also has a lower willingness to pay for higher credibility, allows the content provider to profit from the reader with a relatively neutral ideology, who is willing to pay more for higher credibility. Distortion of the credibility is necessary to screen the reader's prior ideology. Such distortion depends on how the readers process information conveyed by the content, specifically, whether content and ideology are information substitutes

or information complements.

If content and ideology are information substitutes, the optimal contract is characterized in Proposition 1, given Assumption 2.

Assumption 2. *The marginal virtual rent is monotone in ideological types within $[0, \tilde{\phi}]$ and $[\tilde{\phi}, 1]$, respectively. Specifically, $\frac{F(\phi) - F(\tilde{\phi})}{f(\phi)} \cdot \frac{\partial^2 \sigma(\phi, q_1)}{\partial \phi \partial q_1}$ is decreasing in ϕ for $\phi > \tilde{\phi}$, and $\frac{F(\tilde{\phi}) - F(\phi)}{f(\phi)} \cdot \frac{\partial^2 (1 - \sigma(\phi, q_0))}{\partial \phi \partial q_0}$ is increasing in ϕ for $\phi < \tilde{\phi}$.*

Proposition 1. *If prior ideology and content are information substitutes and Assumption 2 is satisfied, the optimal content-providing contract has the following screening property.*

1. *The ex-post indifferent reader takes the most credible content of either stance, $q_1^*(\tilde{\phi}) = 1$ and $q_0^*(\tilde{\phi}) = 0$.*
2. *A reader of ideology $\phi > \tilde{\phi}$ takes the content supporting the new regime with declining credibility in ϕ , $q_1^*(\phi) \in [\tilde{q}, 1]$ with $\frac{dq_1^*(\phi)}{d\phi} \leq 0$.*
3. *A reader of ideology $\phi < \tilde{\phi}$ takes the content supporting the status quo with declining credibility in $1 - \phi$, $q_0^*(\phi) \in [0, \tilde{q}]$ with $\frac{dq_0^*(\phi)}{d\phi} \leq 0$.*
4. *A reader of ideology closer to the ex-post indifferent type pays more for a more credible content, $\frac{dt_1^*(\phi)}{d\phi} \leq 0$ and $\frac{dt_0^*(\phi)}{d\phi} \geq 0$.*

Proof. Lemma 1 to Lemma 3, and Appendix A4. □

The ex-post indifferent type of reader resembles the “efficient type” in standard contracting. The content provider induces him to take the most credible content at the highest transfer. Given information substitutes, a reader with a stronger prior ideology towards the new regime (respectively, status quo) than the ex-post indifferent type has a lower marginal value on the credibility of content supporting the new regime (respectively, status quo), as well as a lower willingness to pay for the more credible content. Therefore, by Lemma 1, within-stance incentive compatibility requires that the content-providing contract exhibits declining credibility and transfer as the reader’s prior ideology being farther from the ex-post indifferent type, so that a reader of a stronger ideology has no incentive to take the more credible content of the same stance, and vice versa. This contract is also across-stance incentive compatible¹⁵ in the sense that the types of readers who are induced to take the pro-new-regime content have

¹⁵This is shown in Lemma A1 in Appendix A4.

no incentive to take the pro-status-quo content, and vice versa. Intuitively, a reader enjoys a higher value of content of the opposite stance only if such content is highly credible. With declining credibility and transfer as the ideology is farther from the ex-post indifferent type, this is as if the reader mimics a type closer to the ex-post indifferent, who has a higher willingness to pay for the more credible content. Such deviation must not be payoff-improving for the reader.

Decreasing credibility of content with respect to a stronger ideology is indeed optimal for the content provider if Assumption 2 is satisfied. The distortion on credibility of content exhibits a tradeoff between affirmation and rent extraction, which depends on the distribution of the reader's ideological types, as well as on how a reader updates his belief upon reading the full content. These are captured in the marginal virtual rent in Assumption 2. It has two major departures from the monotone virtual rent assumed in a standard screening problem. For a reader with a stronger ideology towards the new regime (respectively, status quo) than the ex-post indifferent type, a higher ϕ (respectively, a lower ϕ) indicates a more efficient type. The first element of the marginal virtual rent resembles the inverse hazard rate within each range of ideological types. The marginal virtual rent is also related to how sensitive the reader's belief updating is to the content, or how close an information substitute the content is to the prior ideology, captured by the magnitude of the second element of the marginal virtual rent. Given Assumption 2, a reader of a stronger ideology is less sensitive to more credible content, and such decreased sensitivity is of a larger magnitude for a stronger ideological type. Distortion of credibility for the stronger ideological types reduces rent to the weaker ideological types at a smaller loss of affirmation.

Proposition 1 does not rule out the possibility of pooling for the extreme ideological types of readers. Depending on how the reader updates his belief from the content (e.g., Bayesian updating in the next section), strictly decreasing credibility in a stronger ideology can lead to a less assured belief for a sufficiently extreme type of reader. This type of reader is willing to accept the content only if he is compensated. The content provider has no intrinsic preference for the reader's action, so it is optimal to avoid the negative transfer by providing the commonly recognized neutral content for free to the reader with a sufficiently strong ideology of either stance, which is, by construction, individually rational and incentive compatible.

Content providers such as journals and online streaming provide both free content and extended content at a pricing plan. The screening property in Proposition 1 provides a possible explanation for such a menu of content.

If content and ideology are information complements, the optimal contract is char-

acterized in Proposition 2.

Proposition 2. *If prior ideology and content are information complements, the optimal content-providing contract has the following bang-bang property.*

1. *A reader of relatively extreme ideology $\phi > \bar{\phi}$ and $\phi < \underline{\phi}$, $0 < \underline{\phi} < \bar{\phi} < 1$, takes the commonly recognized neutral content for free.*
2. *A reader of ideology $\phi \in [\tilde{\phi}, \bar{\phi}]$ takes the fully credible content supporting the new regime at a fixed price, $q_1^*(\phi) = 1$ at $t_1^*(\phi) = t_1^*(\bar{\phi})$ such that $u(\bar{\phi}) = \max\{\bar{\phi}, 1 - \bar{\phi}\}$.*
3. *A reader of ideology $\phi \in [\underline{\phi}, \tilde{\phi}]$ takes the fully credible content supporting the status quo at a fixed price, $q_0^*(\phi) = 0$ at $t_0^*(\phi) = t_0^*(\underline{\phi})$ such that $u(\underline{\phi}) = \max\{\underline{\phi}, 1 - \underline{\phi}\}$.*

Proof. Lemma 1 to Lemma 3, and Appendix A5. □

Given information complements, a reader with a stronger ideology has a larger marginal value on the credibility of content supporting a given stance, but he is willing to pay less for the content. With the presence of such countervailing incentives, the optimal contract includes fully credible content of opposite stances, each at a fixed price. If the provider induces all types of readers to take the fully credible content, it is individually rational only at zero transfer. The provider can be better off providing commonly recognized neutral content for free to the reader of relatively extreme ideology, who has a lower willingness to pay for fully credible content. This allows the content provider to raise the transfer for fully credible content without violating incentive compatibility and individual rationality.

4 Content Provision with Bayesian Beliefs

To characterize a tractable content-providing contract, suppose that the readers update beliefs à la Bayesian, $\sigma(\phi, q) = \frac{\phi \cdot q}{\phi \cdot q + (1 - \phi) \cdot (1 - q)}$. Under this belief updating, the content and prior ideology are information substitutes, and the commonly recognized neutral content is $\tilde{q} = \frac{1}{2}$. The optimal contract with Bayesian readers is characterized in Proposition 3, given Assumption 3.

Assumption 3. $\frac{F(\phi) - F(\tilde{\phi})}{f(\phi)}$ is increasing in ϕ for $\phi > \tilde{\phi}$ and $\frac{F(\tilde{\phi}) - F(\phi)}{f(\phi)}$ is decreasing in ϕ for $\phi < \tilde{\phi}$.

Proposition 3. *Suppose the readers have Bayesian beliefs, and Assumption 3 is satisfied. The optimal content-providing contract has the following screening property, with $0 < \bar{\phi}_0 < \tilde{\phi}_0 < \tilde{\phi} = \frac{1}{2} < \tilde{\phi}_1 < \bar{\phi}_1 < 1$.*

1. *A reader of relatively neutral ideology $\phi \in [\tilde{\phi}, \tilde{\phi}_1]$ or $\phi \in [\tilde{\phi}_0, \tilde{\phi}]$ takes fully credible content of either stance, $q_1^*(\phi) = 1$ or $q_0^*(\phi) = 0$ respectively.*
2. *A reader of sufficiently extreme ideology $\phi > \bar{\phi}_1$ or $\phi < \bar{\phi}_0$ takes the commonly recognized neutral content for free.*
3. *A reader of ideology $\phi \in (\tilde{\phi}_1, \bar{\phi}_1)$ takes the content supporting the new regime with declining credibility in ϕ , $q_1^*(\phi) \in (\tilde{q}, 1)$ with $\frac{dq_1^*(\phi)}{d\phi} < 0$.*
4. *A reader of ideology $\phi \in (\bar{\phi}_0, \tilde{\phi}_0)$ takes the content supporting the status quo with declining credibility in $1 - \phi$, $q_0^*(\phi) \in (0, \tilde{q})$ with $\frac{dq_0^*(\phi)}{d\phi} < 0$.*

Proof. Lemma 1 to Lemma 3, and Appendix A6. □

The optimal content-providing contract is symmetric, with the ex-post indifferent type being the ex-ante neutral type, $\tilde{\phi} = \frac{1}{2}$. For a reader of a sufficiently neutral ideology, fully credible content of the same stance is highly valuable. The content provider finds it optimal to provide fully credible content to these types of readers, reducing the credibility of content to the readers of relatively stronger ideology, so that she is able to charge a higher transfer for more credible content. By Proposition 1, decreasing credibility of content with respect to a stronger ideology is indeed optimal for the content provider if Assumption 2 is satisfied. However, Bayesian updating exhibits decreasing sensitivity to more credible content at a larger magnitude for a stronger ideological type, so Assumption 3 on the element resembling the inverse hazard rate is sufficient. Given Assumption 3, distortion of credibility for the stronger ideological types reduces rent to the more neutral ideological types at a smaller loss of affirmation. For a reader of a sufficiently extreme ideology, even highly credible content is of little net value. The content provider finds it optimal to provide the commonly recognized neutral content at zero transfer to these types of readers, which is incentive compatible for the relatively neutral types of readers by their respective individual rationality. The contracted content is illustrated with uniformly distributed ideology in Figure 2.

Freemium. The optimal contract in Proposition 3 (and in Proposition 2 as well) exhibits the property of freemium: a menu consists of basic (commonly recognized neu-

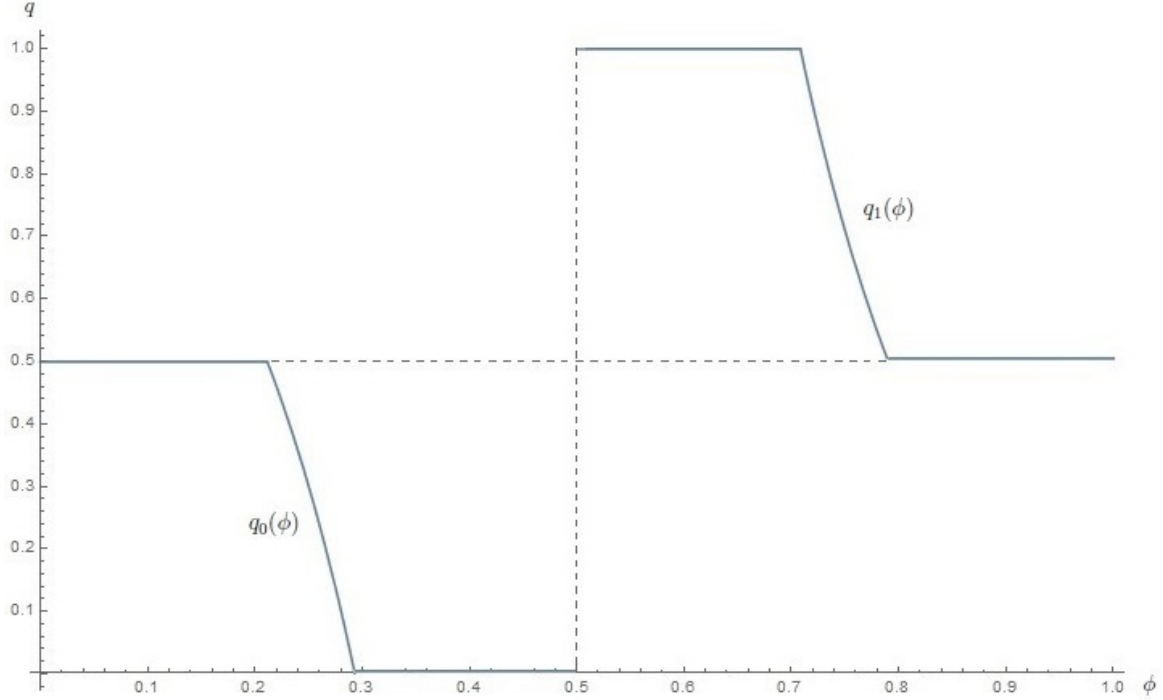


Figure 2: Optimal Content

The optimal content is based on Bayesian belief and uniformly distributed ideology on $[0, 1]$.

tral) content for free and some options of premium content at a price increasing in credibility. Freemium is also found optimal in some studies of the non-informational content provision in digital platforms, e.g., Sato (2019) on the optimality of freemium in a two-sided platform with advertisement, and Halmenschlager and Waelbroeck (2014) on the optimality of freemium to fight against piracy in music streaming platforms. Sato (2019) is closer to this paper in terms of screening, where consumers are segmented by their willingness to interact with (to tolerate) the advertisers. In the current paper, the screening device is the credibility of informational content, and readers are segmented by their prior ideology. Even with the inherent difference between informational and non-informational content, the former having an additional dimension of stance, the optimality of freemium is robust.

Optimal contract in practice. For technical simplicity, I characterized the optimal content-providing contract in a continuous space. The qualitative features remain even if the content provider is restricted to providing a discrete number of options in a menu, which is more consistent with a less complex content-providing contract in reality. The most straightforward way to practically implement the key characteristics of the optimal contract is to offer each piece of content partially for free and an option

to read the rest of the content in full detail at a price, with the full content being more credible than the first few lines of the piece. Alternatively, the provider can offer some basic content for free to everyone and options for in-depth analysis at a price. This in-depth analysis can be in the form of paid-members-only articles/videos or books/documentaries with more details of the same issue.¹⁶ From a quantity perspective, social issues are usually so complicated that they cannot be well-explained in a single article. Content on a single issue is made more credible as a series of articles. The provider can implement the optimal contract by offering limited access to only a few articles for free and more articles in the series at a higher price¹⁷ for readers who demand more credible information on the issue.¹⁸

Other definitions of information substitutes and complements. Börgers, Hernando-Veciana, and Krähmer (2013) define information substitutes and complements in terms of the stochastic relationship between two exogenous signals for any decision problem. In the current paper, their definition describes the equilibrium relationship between the credibility of content and the prior ideology. Information substitutability or complementarity à la Börgers et al. is a choice of the content provider. Revisit Proposition 3 with their definition. The most credible content $q_1^*(\phi) = 1$ and $q_0^*(\phi) = 0$ are substitutes for the reader’s ideology, in the sense that the prior signal is useless once the reader reads the full content.¹⁹ The commonly recognized neutral content and the reader’s ideology are (weak) complements in the sense that the content does not improve the reader’s posterior belief of a state.²⁰ Any other options in

¹⁶For example, the Economist and a Taiwanese independent media, the Reporter, operate under this scheme. Paid-members-only content is also frequently seen on YouTube channels. Baseball Reference, an outlet providing baseball statistics, offers more tools for analysis and customized statistics for paid subscribers.

¹⁷For example, the Washington Post and Common Wealth Magazine of Taiwan operate under this scheme. Rebas, a Taiwanese outlet providing baseball statistics and articles, provides a larger data set and more analytical articles for its paid subscribers.

¹⁸I am not aware of any formal empirical analysis on article-level differentiation of stances. For one real-life example, the Economist had several coverages on the most recent presidential election of Taiwan and its potential impact on regional politics. One article, “America braces for Taiwan’s election,” clearly took the stance of the U.S.; another one, “How China’s public views Taiwan’s elections,” looked at the election from China’s perspective; “Who is Lai Ching-te, the leader in Taiwan’s presidential race?” introduced the candidate from the perspective of his representing political party, while “A presidential candidate on why Taiwan needs a third way” introduced another candidate from the perspective of voters against the candidates from the two major parties.

¹⁹In a two-state, two-signal model, Börgers, Hernando-Veciana, and Krähmer (2013) show that the signals are substitutes if and only if the probability of a state conditional on receiving both signals is equal to the maximum probability of the state conditional on receiving only one signal. This is as if one signal is useless given the other.

²⁰In a two-state, two-signal model, Börgers, Hernando-Veciana, and Krähmer (2013) show that the signals are complements if and only if the probability of a state conditional on receiving both signals

the optimal content-providing contract are neither substitutes nor complements à la Börgers et al.

Formation of posterior belief. Following the optimal content-providing contract in Proposition 3, the formation of the reader’s posterior belief is summarized in the following corollary.

Corollary 1. *The reader’s posterior belief exhibits polarization across stances but convergence within each stance.*

Under the symmetric content-providing contract, a reader of relatively neutral ideology is induced to take highly credible content of the same stance. After reading the full content, he is more assured about his prior stance. On the other hand, a reader of a sufficiently extreme ideology does not update his belief after reading the neutral content. Readers of the same prior stance have closer updated beliefs, while readers of opposite prior stances become more diverged in their updated beliefs. This corollary on polarization across stances echoes the literature on ex-post belief polarization, and along with convergence within stance, it also echoes the literature on media bias and ideological segregation. Both strands of literature are briefly mentioned in the literature review. The difference is that the corollary does not result from the readers choosing different sources of information or processing the same piece of information differently, but from a single content provider screening the reader’s prior ideology. Ideological screening strengthens the echo chamber.

Welfare. With a focus on the affirmational demand for content, the true state of the world does not matter much in the current context, and a reasonable definition of welfare is questionable. Nevertheless, suppose an ad-hoc and straightforward definition: efficiency is reached whenever the equilibrium action matches the real state, e.g., $a = 1$ under the new regime ω_1 . The optimal contract in Proposition 3 provides conforming content to readers of any ideology. No reader of any ideology changes his action after receiving the full content. Therefore, the optimal content-providing contract does not improve welfare, nor does it hurt welfare. It simply redistributes payoffs.

is lower than or equal to the prior probability of the state. There is a reversal of informativeness when receiving both signals, as opposed to receiving only one signal.

5 Conclusion

I characterize the optimal provision of informational content through a menu of options that screens the content reader’s prior ideology and shapes his posterior belief. Screening relies on distortion of content credibility, which exhibits the tradeoff between information rent and affirmation. The content provider is able to extract a higher information rent from a reader with a weaker prior ideology by inducing a reader with a stronger prior ideology of the same stance to take less credible content. This is at the expense of the reader’s affirmation of the real state of the world.

The equilibrium distortion depends on whether the reader regards his prior ideology and the content as information substitutes or information complements. If the ideology and content are information substitutes, the optimal content-providing contract has the screening property: readers with stronger ideology are induced to take less credible content at lower prices, with the most extreme readers induced to take the commonly recognized neutral content for free. If the ideology and content are information complements, the optimal content-providing contract has the bang-bang property: readers with extreme ideology are induced to take the commonly recognized neutral content for free, while readers of non-extreme ideology are induced to take fully credible content of either stance at a fixed price.

I derive a tractable solution to the optimal content-providing contract with Bayesian belief, given which a reader regards his ideology and the content as information substitutes. The optimal content-providing contract exhibits freemium. Readers of relatively neutral ideology are induced to take more credible content at higher prices, while readers of sufficiently extreme ideology are induced to take the commonly recognized neutral content for free. As a corollary, the optimal content-providing contract sheds light on belief polarization and belief congruence. The readers are weakly more assured about their initial stance after receiving the full content. Readers of the same ex-ante stance have congruent posterior beliefs after receiving the full content. In contrast, readers of opposite ex-ante stances have polarized posterior beliefs after receiving the full content.

The analysis is ready for extension in a couple of directions. I have focused on static screening in the current paper. A dynamic screening model is more naturally related to the real-life scenario. With multiple periods, each endowed with an “issue” and the reader’s prior ideology regarding such issue, the prediction of the current paper is robust if the issues and the reader’s prior ideology regarding each issue are independent across time. A more interesting scenario to study is where the reader’s

ideology on the issues is correlated across time. The content provided in each period then screens the correlated per-period ideologies and shapes the future ideologies. This requires a much more advanced analysis toolkit and is left for future research. In addition, there is a single content provider in the current paper. In reality, multiple informational content providers can compete with each other with similar topics, or they can complement each other with various topics. It is intriguing to study how ideological screening interacts with the competition or complementary relationships among multiple content providers.

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A Appendix

A.1 Proof of Lemma 1

Incentive compatible content-providing contract is such that $\phi \in \arg \max_{\hat{\phi}} \{\sigma(\phi, q(\hat{\phi})), 1 - \sigma(\phi, q(\hat{\phi}))\} - t(\hat{\phi})$ for all ϕ . For the sake of clarity, denote the options in the contract that induce updated beliefs of $\sigma(\phi, q(\phi)) > 1 - \sigma(\phi, q(\phi))$ given truthful revelation as $\{(q_1(\phi), t_1(\phi))\}$ and those that induce updated beliefs of $\sigma(\phi, q(\phi)) < 1 - \sigma(\phi, q(\phi))$ given truthful revelation as $\{(q_0(\phi), t_0(\phi))\}$.

The reader of ideological type ϕ induced to take $\{(q_1(\phi), t_1(\phi))\}$ has incentive to truthfully reveals his prior ideology if the following first-order and second-order conditions are satisfied at $\hat{\phi} = \phi$, $\frac{\partial \sigma(\phi, q_1)}{\partial q_1} \cdot q'_1(\hat{\phi}) - t'_1(\hat{\phi}) = 0$ and $\frac{\partial^2 \sigma(\phi, q_1)}{\partial q_1^2} \cdot (q'_1(\hat{\phi}))^2 + \frac{\partial \sigma(\phi, q_1)}{\partial q_1} \cdot q''_1(\hat{\phi}) - t''_1(\hat{\phi}) \leq 0$. At $\hat{\phi} = \phi$, the first-order condition holds with identity, first-order derivative of which with respect to ϕ yields $\frac{\partial^2 \sigma(\phi, q_1)}{\partial q_1^2} \cdot (q'_1(\phi))^2 + \frac{\partial \sigma(\phi, q_1)}{\partial q_1} \cdot q''_1(\phi) - t''_1(\hat{\phi}) + \frac{\partial^2 \sigma(\phi, q_1)}{\partial q_1 \partial \phi} \cdot q'_1(\phi) = 0$. The second-order condition holds if $\frac{\partial^2 \sigma(\phi, q_1)}{\partial q_1 \partial \phi} \cdot q'_1(\phi) \geq 0$. If

the prior belief and content are information substitutes in the sense that $\frac{\partial^2 \sigma(\phi, q_1)}{\partial q_1 \partial \phi} < 0$, incentive compatibility requires $q'_1(\phi) \leq 0$ and $t'_1(\phi) \leq 0$; if the prior belief and content are information complements in the sense that $\frac{\partial^2 \sigma(\phi, q_1)}{\partial q_1 \partial \phi} > 0$, incentive compatibility requires $q'_1(\phi) \geq 0$ and $t'_1(\phi) \geq 0$.

The reader of ideological type ϕ induced to take $\{(q_0(\phi), t_0(\phi))\}$ has incentive to truthfully reveals his prior ideology if the following first-order and second-order conditions are satisfied at $\hat{\phi} = \phi$, $\frac{\partial(1-\sigma(\phi, q_0))}{\partial q_0} \cdot q'_0(\hat{\phi}) - t'_0(\hat{\phi}) = 0$ and $\frac{\partial^2(1-\sigma(\phi, q_0))}{\partial q_0^2} \cdot (q'_0(\hat{\phi}))^2 + \frac{\partial(1-\sigma(\phi, q_0))}{\partial q_0} \cdot q''_0(\hat{\phi}) - t''_0(\hat{\phi}) \leq 0$. At $\hat{\phi} = \phi$, the first-order condition holds with identity, first-order derivative of which with respect to ϕ yields $\frac{\partial^2(1-\sigma(\phi, q_0))}{\partial q_0^2} \cdot (q'_0(\phi))^2 + \frac{\partial(1-\sigma(\phi, q_0))}{\partial q_0} \cdot q''_0(\phi) - t''_0(\phi) + \frac{\partial^2(1-\sigma(\phi, q_0))}{\partial q_0 \partial \phi} \cdot q'_0(\phi) = 0$. The second-order condition holds if $\frac{\partial^2(1-\sigma(\phi, q_0))}{\partial q_0 \partial \phi} \cdot q'_0(\phi) \geq 0$. If the prior belief and content are information substitutes in the sense that $\frac{\partial^2(1-\sigma(\phi, q_0))}{\partial q_0 \partial \phi} < 0$, incentive compatibility requires $q'_0(\phi) \leq 0$ and $t'_0(\phi) \geq 0$; if the prior belief and content are information complements in the sense that $\frac{\partial^2(1-\sigma(\phi, q_0))}{\partial q_0 \partial \phi} > 0$, incentive compatibility requires $q'_0(\phi) \geq 0$ and $t'_0(\phi) \leq 0$.

A.2 Proof of Lemma 2

Given incentive compatibility, the content-providing contract is individually rational if $u(\phi) \geq \max\{\phi, 1 - \phi\}$ for all ϕ . For clarity, denote the reader's payoff implemented by $\{(q_1(\phi), t_1(\phi))\}$ as $u_1(\phi)$ and that implemented by $\{(q_0(\phi), t_0(\phi))\}$ as $u_0(\phi)$. By the envelope theorem of the reader's truthful revelation, $u'_1(\phi) = \frac{\partial \sigma(\phi, q_1(\phi))}{\partial \phi} > 0$ and $u'_0(\phi) = \frac{\partial(1-\sigma(\phi, q_0(\phi)))}{\partial \phi} < 0$.

If $u'_1(\phi) > 1$ for some sufficiently large $\phi > \frac{1}{2}$, $u_1(\phi) - \phi$ is increasing for these types. Individual rationality is binding at $\phi = \phi' < 1$ and slacking for $\phi > \phi'$. Payoff $u_1(\phi) > 1$ is implemented by $t_1(1) < 0$. This is not optimal for the content provider. The content provider can be better off by offering the commonly recognized neutral content $\tilde{q}$ with zero transfer to the reader of type $\phi = 1$ instead, which is individually rational for type $\phi = 1$ and incentive compatible for other types given their respective individual rationality. If the reader with sufficiently large ϕ is induced to take $\{(q_1(\phi), t_1(\phi))\}$ with $u'_1(\phi) < 1$ or induced to take $\{(q_0(\phi), t_0(\phi))\}$, $u_1(\phi) - \phi$ or $u_0(\phi) - \phi$ is diminishing for these types. Individual rationality is binding for at least the reader with $\phi = 1$.

If $u'_0(\phi) < -1$ for some sufficiently small $\phi < \frac{1}{2}$, $u_0(\phi) - (1 - \phi)$ is diminishing for these types. Individual rationality is binding at $\phi = \phi' > 0$ and slacking for $\phi = 0$. Payoff $u_0(0) > 1$ is implemented by $t_0(0) < 0$. This is not optimal for the

content provider as she can be better off offering the commonly recognized neutral content $\tilde{q}$ with zero transfer to the reader of type $\phi = 0$ instead, which is individually rational for type $\phi = 0$ and incentive compatible for other types given their respective individual rationality. If the reader with sufficiently small ϕ is induced to take $\{(q_0(\phi), t_0(\phi))\}$ with $u'_0(\phi) > -1$ or induced to take $\{(q_1(\phi), t_1(\phi))\}$, $u_0(\phi) - (1 - \phi)$ or $u_1(\phi) - (1 - \phi)$ is increasing for these types. Individual rationality is binding for at least the reader with $\phi = 0$.

A.3 Proof of Lemma 3

By the envelope theorem of the reader's truthful revelation, $u'_1(\phi) = \frac{\partial \sigma(\phi, q_1(\phi))}{\partial \phi} > 0$ and $u'_0(\phi) = \frac{\partial (1 - \sigma(\phi, q_0(\phi)))}{\partial \phi} < 0$. By continuity, the contract either induces the reader of types $\phi > \tilde{\phi}$ to take $\{(q_1(\phi), t_1(\phi))\}$ and the reader of types $\phi < \tilde{\phi}$ to take $\{(q_0(\phi), t_0(\phi))\}$, or induces the reader of types $\phi > \tilde{\phi}$ to take $\{(q_0(\phi), t_0(\phi))\}$ and the reader of types $\phi < \tilde{\phi}$ to take $\{(q_1(\phi), t_1(\phi))\}$. Suppose that the reader of types $\phi > \tilde{\phi}$ is induced to take $\{(q_0(\phi), t_0(\phi))\}$ and the reader of types $\phi < \tilde{\phi}$ is induced to take $\{(q_1(\phi), t_1(\phi))\}$. The implemented payoffs are $u_1(\phi) = u_1(0) + \int_0^\phi \frac{\partial \sigma(x, q_1(x))}{\partial x} dx$ and $u_0(\phi) = u_0(1) - \int_\phi^1 \frac{\partial (1 - \sigma(x, q_0(x)))}{\partial x} dx$. By binding individual rationality at $\phi = 1$ and at $\phi = 0$, $u_1(0) = 1$ and $u_0(1) = 1$. These payoffs can be implemented only by $t_0(\phi) < 0$ and $t_1(\phi) < 0$. The content provider can be better off providing the commonly recognized neutral content $\tilde{q}$ at zero transfer to the reader.

Given Assumption 1-2, for any $\phi > \tilde{\phi}$, the content of credibility $q_1(\phi) < \tilde{q}$ implements the posterior belief $\sigma(\phi, q_1(\phi)) < \phi \leq \max\{\phi, 1 - \phi\}$. The reader is willing to accept this contract only if $t_1(\phi) < 0$. For any $\phi < \tilde{\phi}$, the content of credibility $q_0(\phi) > \tilde{q}$ implements the posterior belief $1 - \sigma(\phi, q_0(\phi)) < 1 - \phi \leq \max\{\phi, 1 - \phi\}$. The reader is willing to accept this contract only if $t_0(\phi) < 0$. There is an alternative contract in which the commonly recognized neutral content $\tilde{q}$ at zero transfer replaces $q_1(\phi) < \tilde{q}$ at $t_1(\phi) < 0$ and $q_0(\phi) > \tilde{q}$ at $t_0(\phi) < 0$, other parts of the contract remaining the same. This alternative contract is incentive compatible for the types that are induced to take $\tilde{q}$ by Lemma 1 and is incentive compatible for the types that are induced to take $q_1(\phi) > \tilde{q}$ and $q_0(\phi) < \tilde{q}$ given their respective individual rationality. The content provider is better off proposing the alternative contract instead.

A.4 Proof of Proposition 1

By Lemma 1 to Lemma 3, the reader's implemented payoff has $u_1(\phi) = u_1(1) - \int_\phi^1 \frac{\partial \sigma(x, q_1(x))}{\partial x} dx = 1 - \int_\phi^1 \frac{\partial \sigma(x, q_1(x))}{\partial x} dx$ and $u_0(\phi) = u_0(0) + \int_0^\phi \frac{\partial (1 - \sigma(x, q_0(x)))}{\partial x} dx = 1 +$

$\int_0^{\tilde{\phi}} \frac{\partial(1-\sigma(x, q_0(x)))}{\partial x} dx$. By definition of ex-post indifference, $u_1(\tilde{\phi}) = u_0(\tilde{\phi})$ implies $\int_{\tilde{\phi}}^1 \frac{\partial\sigma(\phi, q_1(\phi))}{\partial\phi} d\phi + \int_0^{\tilde{\phi}} \frac{\partial(1-\sigma(\phi, q_0(\phi)))}{\partial\phi} d\phi = 0$. The content provider's contracting problem is reduced to

$$\max_{q(\phi), \tilde{\phi}} \int_0^1 \mathbf{1}_{\phi \geq \tilde{\phi}} \cdot (\sigma(\phi, q_1(\phi)) - u_1(\phi)) + \mathbf{1}_{\phi \leq \tilde{\phi}} \cdot (1 - \sigma(\phi, q_0(\phi)) - u_0(\phi)) dF(\phi)$$

subject to $q_1(\phi) \in [\tilde{q}, 1]$ and $q_0(\phi) \in [0, \tilde{q}]$ by Lemma 3, and $q'_i(\phi) \leq 0$ for $i = 0, 1$ by Lemma 1, where $u_1(\phi) = 1 - \int_{\phi}^1 \frac{\partial\sigma(x, q_1(x))}{\partial x} dx$ and $u_0(\phi) = 1 + \int_0^{\phi} \frac{\partial(1-\sigma(x, q_0(x)))}{\partial x} dx$. Indicator functions $\mathbf{1}_{\phi \geq \tilde{\phi}} = 1$ or $\mathbf{1}_{\phi \leq \tilde{\phi}} = 1$ if $\phi \geq \tilde{\phi}$ or $\phi \leq \tilde{\phi}$ respectively, zero otherwise. Applying integration by parts, $\int_{\tilde{\phi}}^1 \left(\int_{\phi}^1 \frac{\partial\sigma(x, q_1(x))}{\partial x} dx \right) dF(\phi) = - \int_{\tilde{\phi}}^1 \frac{\partial\sigma(\phi, q_1(\phi))}{\partial\phi} d\phi \cdot F(\tilde{\phi}) + \int_{\tilde{\phi}}^1 F(\phi) \cdot \frac{\partial\sigma(\phi, q_1(\phi))}{\partial\phi} d\phi = \int_{\tilde{\phi}}^1 \frac{F(\phi) - F(\tilde{\phi})}{f(\phi)} \cdot \frac{\partial\sigma(\phi, q_1(\phi))}{\partial\phi} dF(\phi)$ and $\int_0^{\tilde{\phi}} \left(\int_0^{\phi} \frac{\partial(1-\sigma(x, q_0(x)))}{\partial x} dx \right) dF(\phi) = \int_0^{\tilde{\phi}} \frac{\partial(1-\sigma(\phi, q_0(\phi)))}{\partial\phi} d\phi \cdot F(\tilde{\phi}) - \int_0^{\tilde{\phi}} F(\phi) \cdot \frac{\partial(1-\sigma(\phi, q_0(\phi)))}{\partial\phi} d\phi = \int_0^{\tilde{\phi}} \frac{F(\tilde{\phi}) - F(\phi)}{f(\phi)} \cdot \frac{\partial(1-\sigma(\phi, q_0(\phi)))}{\partial\phi} dF(\phi)$. The contracting problem is further reduced to

$$\begin{aligned} \max_{q(\phi), \tilde{\phi}} \int_0^1 \mathbf{1}_{\phi \geq \tilde{\phi}} \cdot \left(\sigma(\phi, q_1(\phi)) + \frac{F(\phi) - F(\tilde{\phi})}{f(\phi)} \cdot \frac{\partial\sigma(\phi, q_1(\phi))}{\partial\phi} \right) \\ + \mathbf{1}_{\phi \leq \tilde{\phi}} \cdot \left(1 - \sigma(\phi, q_0(\phi)) - \frac{F(\tilde{\phi}) - F(\phi)}{f(\phi)} \cdot \frac{\partial(1 - \sigma(\phi, q_0(\phi)))}{\partial\phi} \right) dF(\phi) \end{aligned}$$

subject to $q_1(\phi) \in [\tilde{q}, 1]$, $q_0(\phi) \in [0, \tilde{q}]$, and $q'_i(\phi) \leq 0$ for $i = 0, 1$.

The pointwise optimality conditions regarding $q_1(\phi)$ are such that $q_1(\phi) \in (\tilde{q}, 1)$ solves $\frac{\partial\sigma(\phi, q_1)}{\partial q_1} + \frac{F(\phi) - F(\tilde{\phi})}{f(\phi)} \cdot \frac{\partial^2\sigma(\phi, q_1)}{\partial\phi\partial q_1} = 0$, $q_1(\phi) = 1$ for $\frac{\partial\sigma(\phi, q_1)}{\partial q_1} + \frac{F(\phi) - F(\tilde{\phi})}{f(\phi)} \cdot \frac{\partial^2\sigma(\phi, q_1)}{\partial\phi\partial q_1} > 0$ at $q_1 = 1$, and $q_1(\phi) = \tilde{q}$ for $\frac{\partial\sigma(\phi, q_1)}{\partial q_1} + \frac{F(\phi) - F(\tilde{\phi})}{f(\phi)} \cdot \frac{\partial^2\sigma(\phi, q_1)}{\partial\phi\partial q_1} < 0$ at $q_1 = \tilde{q}$. With $\frac{\partial^2\sigma(\phi, q_1)}{\partial\phi\partial q_1} < 0$, $q'_1(\phi) < 0$ if $\frac{F(\phi) - F(\tilde{\phi})}{f(\phi)} \cdot \frac{\partial^2\sigma(\phi, q_1)}{\partial\phi\partial q_1}$ is decreasing in ϕ (or its absolute value is increasing in ϕ). The pointwise optimality conditions regarding $q_0(\phi)$ are such that $q_0(\phi) \in (0, \tilde{q})$ solves $\frac{\partial(1-\sigma(\phi, q_0))}{\partial q_0} - \frac{F(\tilde{\phi}) - F(\phi)}{f(\phi)} \cdot \frac{\partial^2(1-\sigma(\phi, q_0))}{\partial\phi\partial q_0} = 0$, $q_0(\phi) = 0$ for $\frac{\partial(1-\sigma(\phi, q_0))}{\partial q_0} - \frac{F(\tilde{\phi}) - F(\phi)}{f(\phi)} \cdot \frac{\partial^2(1-\sigma(\phi, q_0))}{\partial\phi\partial q_0} < 0$ at $q_0 = 0$, and $q_0(\phi) = \tilde{q}$ for $\frac{\partial(1-\sigma(\phi, q_0))}{\partial q_0} - \frac{F(\tilde{\phi}) - F(\phi)}{f(\phi)} \cdot \frac{\partial^2(1-\sigma(\phi, q_0))}{\partial\phi\partial q_0} > 0$ at $q_0 = \tilde{q}$. With $\frac{\partial^2(1-\sigma(\phi, q_0))}{\partial\phi\partial q_0} < 0$, $q'_0(\phi) < 0$ if $\frac{F(\tilde{\phi}) - F(\phi)}{f(\phi)} \cdot \frac{\partial^2(1-\sigma(\phi, q_0))}{\partial\phi\partial q_0}$ is increasing in ϕ (or its absolute value is decreasing in ϕ). Specifically, for the ex-post indifferent type $\tilde{\phi}$, he is made indifferent between the fully credible content of opposite stances $q_1(\tilde{\phi}) = 1$ and $q_0(\tilde{\phi}) = 0$. The optimal choice of the ex-post indifferent type of reader $\tilde{\phi}$ is such that $\int_{\tilde{\phi}}^1 \left(-\frac{f(\tilde{\phi})}{f(\phi)} \cdot \frac{\partial\sigma(\phi, q_1(\phi))}{\partial\phi} \right) dF(\phi) + \int_0^{\tilde{\phi}} \left(-\frac{f(\tilde{\phi})}{f(\phi)} \cdot \frac{\partial(1-\sigma(\phi, q_0(\phi)))}{\partial\phi} \right) dF(\phi) - \sigma(\tilde{\phi}, q_1(\tilde{\phi})) + 1 - \sigma(\tilde{\phi}, q_0(\tilde{\phi})) = 0$. This equality holds at $\sigma(\tilde{\phi}, q_1(\tilde{\phi})) = 1 - \sigma(\tilde{\phi}, q_0(\tilde{\phi}))$ as $\int_{\tilde{\phi}}^1 \frac{\partial\sigma(\phi, q_1(\phi))}{\partial\phi} d\phi + \int_0^{\tilde{\phi}} \frac{\partial(1-\sigma(\phi, q_0(\phi)))}{\partial\phi} d\phi = 0$ implied by definition of ex-post indifference.

What is left to check is whether the reader has an incentive to take an option that

induces a different stance from that the content provider intends to implement, i.e., incentive compatibility across stances.

Lemma A1. *Given the above contract, the reader with $\phi > \tilde{\phi}$ has no incentive to take any option in $\{(q_0(\phi), t_0(\phi))\}$ that flips his stance, and the reader with $\phi < \tilde{\phi}$ has no incentive to take any option in $\{(q_1(\phi), t_1(\phi))\}$ that flips his stance.*

Proof. We first argue that the reader with $\phi > \tilde{\phi}$ has no incentive to take the option $(q_0(\phi'), t_0(\phi'))$ that implements the same ex-post value of content, i.e., $q_0(\phi')$ such that $\sigma(\phi, q_1(\phi)) = 1 - \sigma(\phi, q_0(\phi'))$. Given $\frac{dq_i(\phi)}{d\phi} < 0$ for $i = 0, 1$, ϕ is a “more extreme” type than ϕ' relative to $\tilde{\phi}$. Given $\frac{dt_1(\phi)}{d\phi} < 0$ and $\frac{dt_0(\phi)}{d\phi} > 0$, the type- ϕ reader has no incentive to mimic the type- ϕ' reader, anticipating the same ex-post value of content at a higher transfer. By symmetric argument, the reader with $\phi < \tilde{\phi}$ has no incentive to take the option $(q_1(\phi'), t_1(\phi'))$ that implements the same ex-post value of content, i.e., $q_1(\phi')$ such that $1 - \sigma(\phi, q_0(\phi)) = \sigma(\phi, q_1(\phi'))$. Next we argue that the reader with $\phi > \tilde{\phi}$ has no incentive to take the option $(q_0(\phi'), t_0(\phi'))$ that implements a different ex-post value of content, i.e., $q_0(\phi')$ such that $\sigma(\phi, q_1(\phi)) \neq 1 - \sigma(\phi, q_0(\phi'))$. By continuity, there is type $\phi'' > \tilde{\phi}$ such that the type- ϕ reader expects $\sigma(\phi, q_1(\phi'')) = 1 - \sigma(\phi, q_0(\phi'))$. Given $\frac{dq_i(\phi)}{d\phi} < 0$ for $i = 0, 1$, ϕ'' is a “more extreme” type than ϕ' , and given $\frac{dt_1(\phi)}{d\phi} < 0$ and $\frac{dt_0(\phi)}{d\phi} > 0$, the type- ϕ reader expects a lower payoff mimicking the type- ϕ' reader than mimicking the type- ϕ'' reader. By incentive compatibility in Lemma 1, the type- ϕ reader has no incentive to mimic the type- ϕ'' reader. He thus has no incentive to mimic the type- ϕ' reader, either. By symmetric argument, the reader with $\phi < \tilde{\phi}$ has no incentive to take the option $(q_1(\phi'), t_1(\phi'))$ that implements a different ex-post value of content, i.e., $q_1(\phi')$ such that $1 - \sigma(\phi, q_0(\phi)) \neq \sigma(\phi, q_1(\phi'))$. $\square$

A.5 Proof of Proposition 2

Lemma 1 to Lemma 3 hold for information complements as well, as the proofs do not rely on information substitutability. The content provider’s contracting problem is reduced to

$$\begin{aligned} \max_{q(\phi), \phi} \int_0^1 \mathbf{1}_{\phi \geq \tilde{\phi}} \cdot \left(\sigma(\phi, q_1(\phi)) + \frac{F(\phi) - F(\tilde{\phi})}{f(\phi)} \cdot \frac{\partial \sigma(\phi, q_1(\phi))}{\partial \phi} \right) \\ + \mathbf{1}_{\phi \leq \tilde{\phi}} \cdot \left(1 - \sigma(\phi, q_0(\phi)) - \frac{F(\tilde{\phi}) - F(\phi)}{f(\phi)} \cdot \frac{\partial (1 - \sigma(\phi, q_0(\phi)))}{\partial \phi} \right) dF(\phi) \end{aligned}$$

subject to $q_1(\phi) \in [\tilde{q}, 1]$, $q_0(\phi) \in [0, \tilde{q}]$, and $q'_i(\phi) \geq 0$ for $i = 0, 1$. The pointwise first-order derivative with respect to $q_1(\phi)$ has $\frac{\partial \sigma(\phi, q_1)}{\partial q_1} + \frac{F(\phi) - F(\tilde{\phi})}{f(\phi)} \cdot \frac{\partial^2 \sigma(\phi, q_1)}{\partial \phi \partial q_1} > 0$ for all $\phi \geq \tilde{\phi}$ when $\frac{\partial^2 \sigma(\phi, q_1)}{\partial \phi \partial q_1} > 0$, and that with respect to $q_0(\phi)$ has $\frac{\partial(1 - \sigma(\phi, q_0))}{\partial q_0} - \frac{F(\tilde{\phi}) - F(\phi)}{f(\phi)} \cdot \frac{\partial^2(1 - \sigma(\phi, q_0))}{\partial \phi \partial q_0} < 0$ for all $\phi \leq \tilde{\phi}$ when $\frac{\partial^2(1 - \sigma(\phi, q_0))}{\partial \phi \partial q_0} > 0$. The content-providing contract that induces full participation of the reader has $q_1(\phi) = 1$ for all $\phi \geq \tilde{\phi}$ and $q_0(\phi) = 0$ for all $\phi \leq \tilde{\phi}$. This contract is individually rational only if $t_1(\phi) = t_0(\phi) = 0$ so that the most extreme type-1 and type-0 readers are willing to accept this contract. The content provider earns zero payoff.

The content provider can be better off proposing an alternative contract: $q_1(\phi) = 1$ at transfer $t_1(\phi) = t_1(\bar{\phi})$ for $\phi \in [\bar{\phi}, \bar{\phi}]$ and $q_0(\phi) = 0$ at transfer $t_0(\phi) = t_0(\underline{\phi})$ for $\phi \in [\underline{\phi}, \underline{\phi}]$ that are consistent to the pointwise optimization above with binding individual rationalities for the reader of types $\bar{\phi}$ and $\underline{\phi}$, while $q_1(\phi) = q_0(\phi) = \tilde{q}$ at zero transfer for $\phi > \bar{\phi}$ and $\phi < \underline{\phi}$, with $0 < \underline{\phi} < \tilde{\phi} < \bar{\phi} < 1$. This is as if the provider gives up contracting with the relatively extreme types by offering them the commonly recognized neutral content so that she can profit from the relatively neutral types of readers. This contract is incentive compatible for $\phi \in [\underline{\phi}, \bar{\phi}]$ not to take the neutral content by their respective individual rationality, and it is incentive compatible for $\phi < \underline{\phi}$ and $\phi > \bar{\phi}$ by Lemma 1. It is incentive compatible for $\phi \in [\bar{\phi}, \bar{\phi}]$ not to take $q_0(\phi) = 0$ as information complementarity implies a higher marginal ex-post value by taking $q_1(\phi) = 1$, vice versa for $\phi \in [\underline{\phi}, \underline{\phi}]$ not to take $q_1(\phi) = 1$.

A.6 Proof of Proposition 3

Lemma A2. *Bayesian belief satisfies Assumption 1. Given Bayesian belief, the intrinsic ideology and the content are information substitutes, i.e., $\frac{\partial^2 \sigma(\phi, q_1)}{\partial \phi \partial q_1} < 0$ for $\sigma(\phi, q_1) > 1 - \sigma(\phi, q_1)$ and $\frac{\partial^2(1 - \sigma(\phi, q_0))}{\partial \phi \partial q_0} < 0$ for $1 - \sigma(\phi, q_0) > \sigma(\phi, q_0)$.*

Proof. To see Assumption 1, $\sigma(\phi, q) = \frac{\phi \cdot q}{\phi \cdot q + (1 - \phi) \cdot (1 - q)}$ given Bayesian belief. There is a commonly recognized neutral content $\tilde{q} = \frac{1}{2}$, such that $\sigma(\phi, \tilde{q}) = \phi$ for all ϕ . The Bayesian belief is increasing in q at any ϕ as $\frac{\partial \sigma(\phi, q)}{\partial q} = \frac{\phi \cdot (1 - \phi)}{(\phi \cdot q + (1 - \phi) \cdot (1 - q))^2} \geq 0$, and it is increasing in ϕ at any q as $\frac{\partial \sigma(\phi, q)}{\partial \phi} = \frac{q \cdot (1 - q)}{(\phi \cdot q + (1 - \phi) \cdot (1 - q))^2} \geq 0$.

With Bayesian belief, $\sigma(\phi, q_1) = \frac{\phi \cdot q_1}{\phi \cdot q_1 + (1 - \phi) \cdot (1 - q_1)} > 1 - \sigma(\phi, q_1)$ if $\phi \cdot q_1 > (1 - \phi) \cdot (1 - q_1)$, which holds if and only if $1 - \phi - q_1 < 0$, and $\sigma(\phi, q_0) = \frac{\phi \cdot q_0}{\phi \cdot q_0 + (1 - \phi) \cdot (1 - q_0)} < 1 - \sigma(\phi, q_0)$ if $\phi \cdot q_0 < (1 - \phi) \cdot (1 - q_0)$, which holds if and only if $1 - \phi - q_0 > 0$. Conditional on $1 - \phi - q_1 < 0$, $\frac{\partial^2 \sigma(\phi, q_1)}{\partial \phi \partial q_1} = \frac{1 - \phi - q_1}{(\phi \cdot q_1 + (1 - \phi) \cdot (1 - q_1))^3} < 0$; conditional on $1 - \phi - q_0 > 0$, $\frac{\partial^2(1 - \sigma(\phi, q_0))}{\partial \phi \partial q_0} = -\frac{1 - \phi - q_0}{(\phi \cdot q_0 + (1 - \phi) \cdot (1 - q_0))^3} < 0$. $\square$

Ideology and content being information substitutes, apply the optimality conditions in Appendix A.4. The optimal content $q_1(\phi) \in (\tilde{q}, 1)$ solves $\frac{\phi \cdot (1-\phi)}{(\phi \cdot q_1(\phi) + (1-\phi) \cdot (1-q_1(\phi)))^2} + \frac{F(\phi) - F(\tilde{\phi})}{f(\phi)} \cdot \frac{1-\phi-q_1}{(\phi \cdot q_1 + (1-\phi) \cdot (1-q_1))^3} = 0$ for $\phi \in (\tilde{\phi}_1, \bar{\phi}_1)$, $q_1(\phi) = 1$ for $\phi \in [\tilde{\phi}, \tilde{\phi}_1]$ such that $\phi \cdot (1-\phi) - \frac{F(\phi) - F(\tilde{\phi})}{f(\phi)} \geq 0$ with equality at $\tilde{\phi}_1$, and $q_1(\phi) = \tilde{q} = \frac{1}{2}$ for $\phi \geq \bar{\phi}_1$ such that $\phi \cdot (1-\phi) + \frac{F(\phi) - F(\tilde{\phi})}{f(\phi)} \cdot (1-2 \cdot \phi) \leq 0$ with equality at $\bar{\phi}_1$. Given $\frac{\partial^2 \sigma(\phi, q_1)}{\partial \phi \partial q_1} < 0$ and that $\frac{1-\phi-q_1}{\phi \cdot q_1 + (1-\phi) \cdot (1-q_1)} < 0$ is diminishing in ϕ , $q'_1(\phi) < 0$ and $\tilde{\phi} < \tilde{\phi}_1 < \bar{\phi}_1 < 1$ if the distribution of ideology satisfies increasing $\frac{F(\phi) - F(\tilde{\phi})}{f(\phi)}$ in ϕ , resembling the monotone hazard rate property. The optimal content $q_0(\phi) \in (0, \tilde{q})$ solves $-\frac{\phi \cdot (1-\phi)}{(\phi \cdot q_0(\phi) + (1-\phi) \cdot (1-q_0(\phi)))^2} + \frac{F(\tilde{\phi}) - F(\phi)}{f(\phi)} \cdot \frac{1-\phi-q_0(\phi)}{(\phi \cdot q_0(\phi) + (1-\phi) \cdot (1-q_0(\phi)))^3} = 0$ for $\phi \in (\bar{\phi}_0, \tilde{\phi}_0)$, $q_0(\phi) = 0$ for $\phi \in [\tilde{\phi}_0, \tilde{\phi}]$ such that $-\phi \cdot (1-\phi) + \frac{F(\tilde{\phi}) - F(\phi)}{f(\phi)} \leq 0$ with equality at $\tilde{\phi}_0$, and $q_0(\phi) = \tilde{q} = \frac{1}{2}$ for $\phi \leq \bar{\phi}_0$ such that $-\phi \cdot (1-\phi) + \frac{F(\tilde{\phi}) - F(\phi)}{f(\phi)} \cdot (1-2 \cdot \phi) \geq 0$ with equality at $\bar{\phi}_0$. Given $\frac{\partial^2 (1-\sigma(\phi, q_0))}{\partial \phi \partial q_0} < 0$ and that $\frac{1-\phi-q_0(\phi)}{\phi \cdot q_0(\phi) + (1-\phi) \cdot (1-q_0(\phi))} > 0$ is diminishing in ϕ , $q'_0(\phi) < 0$ and $0 < \bar{\phi}_0 < \tilde{\phi}_0 < \tilde{\phi}$ if the distribution of ideology satisfies decreasing $\frac{F(\tilde{\phi}) - F(\phi)}{f(\phi)}$ in the same fashion as the monotone hazard rate property. Given Bayesian belief, $\sigma(\phi, 1) = 1 - \sigma(\phi, 0) = 1$ for any ϕ , so $\sigma(\tilde{\phi}, q_1(\tilde{\phi})) = 1 - \sigma(\tilde{\phi}, q_0(\tilde{\phi}))$ at any $\tilde{\phi}$, including the symmetric content provision with $\tilde{\phi} = \frac{1}{2}$.