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COMPETITION AND COGNITION IN THE MARKET FOR ONLINE NEWS

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Competition and Cognition in the Market for Online News

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Abstract

Does it pay to appear unbiased in an attention-based economy where bias sells? We study this question in light of increased consumer partisan polarization and biases alongside greater technology usage and partisanship in journalism. Using a game-theoretic framework that captures the essential properties of the online news market, we show that polarization with biases may constrain neutral and partisan news websites' engagement-enhancing strategies differently; online news providers can strategically exploit consumer perceptions to maximize engagement-driven revenues. Our analysis suggests that neutral news outlets depend on polarization imbalance and perceptions of neutrality. Moreover, increased search costs and consumer bias toward partisan outlets can lessen the echo-chamber effect in online news consumption. Our work advances discussions on online news neutrality, providing fresh insights into the 'marketplace of ideas' view and source versus content neutrality in the face of increasing affective polarization.

***Keywords*—** online news, polarization, engagement, source vs. content bias, cognitive reapportionment

1 Introduction

Since the advent of the internet, advancements in information technology have played a key role in transforming news production and shaping consumers' political engagement and information-seeking behaviors [66, 37]. News organizations have expanded their operations using online advertising revenues [107]. Meanwhile, news consumption has evolved into engagement activities

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like commenting and sharing, facilitated by tools such as email, social media, and smartphones [39]. Underlying these trends is the technology-driven cognitive reapportionment[1] of journalistic tasks and the consumers' biased perceptions of news sources and content amid rising partisan polarization [42].

Using the concept of cognitive reapportionment [71, 38, 95], news organizations can be theorized as *bundles of decisions* regarding journalistic content production. These decisions can be distributed among journalists and various information technology tools. In the face of seemingly limitless information, technology now aids a significant portion of journalistic output in news companies [62]. Therefore, erstwhile static analytic tools have assumed new roles as dynamic information 'distillers' [71], boosting productivity and improving profitability [33]. For example, Associated Press (AP) and Reuters have used automated article-writing technologies to generate profit reports and sports results [28]. More recently, generative AI tools like ChatGPT have been used for writing and editing. News startup Semafor proofreads with AI and British firm Radar AI writes data-driven local newspaper articles. Five of Radar AI's human journalists have filed almost 400,000 partly automated stories since 2018 [33].

Nevertheless, using AI and machine learning (ML) tools in journalism presents a double-edged sword. While ML can analyze vast datasets and find trends, generative AI models occasionally fail to produce factually accurate outputs [39]. Furthermore, unchecked algorithmic production threatens a healthy information environment [81, 77]. For example, AI-generated partisan-framed articles can influence opinions as effectively as those written by humans [73, 3, 61]. In conjunction with online news consumption dynamics, such trends present a concerning scenario. Data on online news consumption reveals communities with distinct political alignments, and such preferential

[1] Refer to Table B.1 in the Online Appendix B for specific examples of such reapportionment

and polarized consumption habits persist at individual and aggregate population levels [42]. Thus, partisan polarization threatens neutral[2] news coverage, and may invite partisan bias in journalism.

Even so, the impact of competing neutral or partisan reporting on a polarized consumer base is unclear. The minimal effects paradigm suggests that news media primarily reinforce existing predispositions, rather than polarizing society [48]. However, more recent findings have shown otherwise. For instance, the 2022 American Views Report by Gallup-Knight [39] revealed that only 15% of Americans who primarily get their news online trust national news organizations, while 47% do not. This suggests that partisan news may lead to significant negative societal spillovers by influencing poor voting decisions [5]. Partisan news could also exacerbate societal and political divisions, leading to greater polarization [114] and creating a vicious cycle of polarization and partisan news framing [81]. Additionally, cognitive tendencies, such as consumer biases, perceptions, and belief updates, could influence polarization [24, 64, 77] and shape partisan news framing.

This paper presents a model of competition in the online news market, considering the trends of partisan polarization and bias in consumption, as well as technology-augmented news production. Specifically, we pose the following questions: *Does pandering to consumer perceptions pay off for competing news websites? Further, how do cognitive biases affect the engagement of polarized consumers with competing news websites?* The economic implications of technology-driven cognitive reapportionment in journalism, its interactions with cognitive biases, and the role of partisan polarization in consumption within the contemporary news landscape[3] have been insufficiently explored. Our flexible and parsimonious model seeks to bridge this knowledge gap.

Our model consists of three news websites (one neutral, two partisan) competing for online user

[2]Online news neutrality [97] implies (1) non-interference, i.e., only transmitting the facts and letting readers decide; (2) non-alignment, i.e., reporting on politics should be impartial to avoid furthering partisan interests.

[3]In Online Appendix A, we highlight the neutral/partisan perceptions of some of the most popular neutral and partisan news sources over the past five years.

engagement from polarized consumers displaying cognitive tendencies related to news source vs. content bias. Our equilibrium analysis suggests that online news providers strategically exploit consumer perceptions to maximize engagement-driven revenues. Further, our analysis indicates that neutral news outlets may benefit from polarization imbalance and perceptions of neutrality, and increased search costs and consumer belief in an outlet's partisan slant can reduce the echo-chamber effect in online news consumption. We extend our main model in several ways and discuss the implications for policymakers and practitioners concerning competition dynamics among online news providers in Section 6. Our analysis suggests the 'marketplace of ideas' view of news market competition is inadequate when consumers hold varying perceptions of the news content and source, and that regulating online news in the presence of the combined effects of news framing and consumer perceptions presents significant challenges. Given these insights, we recommend reassessing online news regulation, which may include revisiting theories such as the Fairness Doctrine [92].

2 Theoretical Foundation

This section introduces the underlying literature, discusses our paper's theoretical foundations, and establishes the definitions and concepts that we will use throughout the paper. While various aspects of news media and digital information platforms have been studied by scholars in journalism, information systems, economics, and political science [e.g., 27, 32, 65, 66], none capture the significance of news provider competition amid polarization and consumer perceptions about source and content bias. Policymakers, scholars, and practitioners need tools and models to identify and explain emergent dynamics as AI increasingly takes over cognitive processes and tasks in news consumption and provision [111, 123]. Our game-theoretic model intends to fill this gap.

Our work intersects with multiple streams of research such as IT and cognitive reapportionment [e.g., 95, 67], news agenda setting [e.g., 79, 10], news framing [e.g., 22, 35], priming [e.g., 26, 84], consumer perceptions and biases [e.g., 82, 121], online fake news [e.g., 68, 94], online platforms [e.g., 60, 67], and online user behavior [e.g., 25, 55]. We study news framing by competing online news websites in a setting where consumers have prior perceptions about websites' neutrality/bias and explore users' responses to the news framing. While framing differs from creating fake news, the two streams are related as both could result in information distortion. In lieu of an extensive literature review, we summarize five studies most relevant to our paper in Table C.1 in the Online Appendix, including a summary of our contributions relative to these studies. Next, in Sections 2.1, 2.2 and 2.3, we discuss key theoretical elements and definitions behind the model and the decisions of news providers and consumers, thus setting up our model introduction in Section 3.

2.1 Cognitive Reapportionment and IT

Cognitive reapportionment, a design concept, considers allocating thinking/cognitive tasks dynamically between humans and systems [71, 70]. Akin to superior-subordinate delegation, where superiors delegate decisions yet retain the authority to retake control, cognitive reapportionment lets humans dynamically share decision-making power with systems or reclaim it. In this setting, humans act as a *co-cognitor* or *computer as a colleague* [71]. Cognitive reapportionment has typically enabled higher productivity and profitability [71, 95, 34]. In one of the early examples of such reapportionment, American Express used the knowledge of its best credit card application assessors to create an expert system which significantly improved productivity by learning the cognitive tasks involved in authorizing credit cards [71].

Similarly, the advent of AI/ML-based tools has resulted in journalistic tasks being reapportioned between humans and systems [28, 14, 11]. Given the cognitive skills and abilities required for journalistic duties [123], and an increasingly competitive labor market for journalists [117, 28], leading news organizations have incorporated advanced analytical tools that "distill" information to enhance reporting quality and decrease production costs, thereby increasing profitability.[4] As we discuss the *quality* of news reports posted by competing news organizations in Section 3.1, we use this premise to model the marginal costs of producing such quality reports and analyze how profitability concerns can determine strategic quality setting in an increasingly competitive market.

2.2 Underlying Theories of News Providers' Decisions

McCombs and Shaw (1972) defined "agenda-setting" as the process through which news outlets determine what is important by choosing what to report and emphasizing specific topics [79]. Second-level agenda setting, or framing, is the selective presentation of aspects of reality to support a particular interpretation [109]. Framing strategies use photos, videos, and interactive multimedia [29] to bias news by emphasizing specific ideas and downplaying others [36]. Political news framing can overshadow issue-based reporting, inhibit informed citizen participation, and encourage political cynicism and division [6]. In this study, we model a news source that employs *neutral framing* [87] alongside two partisan news providers that cater to left and right-partisan readers using *emphasis framing*—an approach that highlights certain aspects of an issue while downplaying others [93]. For instance, emphasis framing might present social welfare as a drain on the budget rather than a system to aid the underprivileged [99].

The rise in partisan polarization has boosted the consumption of news from partisan sites such as The Daily Caller and Vox [124]. At the same time, the increasing popularity of Reuters indicates a growing demand for more objective, fact-based reporting [42, 47]. Consequently, politicians and industry authorities have increasingly focused on competitive practices such as framing by news websites [13]. The process of framing entails frame building, which links real-world events to journalistic narratives [22], and frame setting, which shapes consumers' perceptions of the event [109].

[4]Please see Table B.1 in Online Appendix B for some examples of how news organizations are reapportioning cognitive journalistic tasks among humans and technology (e.g., NLP and generative AI).

In Section 3.1, we will discuss how our model incorporates a neutral news provider, defined as an outlet that delivers news as a blend of objective facts and left- and right-aligned framed news of various qualities, thereby presenting both sides of the political spectrum.

2.3 Underlying Theories of News Consumers' Decisions

Recent studies have linked partisan media consumption to affective polarization, suggesting that news websites may structure narratives to appeal to politically polarized audiences and increase traffic [69, 51]. Affective polarization occurs when political party members like their party and dislike the other party [30]. Social identity processes rooted in party identification, political ideology, or both may cause affective polarization [69]. Thus, political affiliations are usually considered important parts of an individual's social identity, impacting their preferences and behaviors [80]. Iyengar et al. (2012) claim that as partisan news channels gain market share, the alignment between people's political ideas and the news will likely increase [57]. Our model accounts for affective partisan polarization as shown in Section 3.2.

We model cognitively sophisticated consumers who maintain and update demand-side beliefs about the neutrality of news content and sources [125, 119]. Source and content biases are beliefs about news providers and their content. These beliefs affect consumers' beliefs and their expected benefits from consuming the news [12]. Bayesian updating represents consumers' cognitive processing of new information for belief updating in our paradigm [4]. Personal biases can impact consumers' perceptions of channels and news items, which affects engagement levels [42]. Consumers often view news that supports their ideas as unbiased and those that oppose them as biased [122]. Indeed, some neutral news websites have been accused of bias. E.g., Reuters' editor-in-chief defended impartiality early in Trump's presidency.

Traditional leveling vs. sharpening theory [54, 41, 53] has been used to study information distortion [53]. Our model draws from this theory to study how these cognitive tendencies affect consumers' belief updating in response to news provider bias or neutrality. This theory studies how biases might be enhanced or lessened by inputs like reports or evidence; according to early Gestalt psychologists, sharpening exaggerates differences while leveling minimizes them [54]. Our model's cognitive biases affect partisan source and content bias perceptions. Leveling reinforces news consumers' bias or neutrality perceptions. Thus, consumers view neutral or partisan content more intensely. Regardless of content, sharpening reinforces customers' perceptions of a news source's bias or neutrality. Sharpening indicates strengthening source-content perception disparities.

Modeling these cognitive biases allows for a nuanced analysis of engagement influenced by affective polarization. Recent findings demonstrate that polarization may dominate cognitive information processing techniques [49, 110]. Polarization and cognition's combined effect on engagement is currently being explored and appears to be context-dependent, driven by factors like inter-country disparities and geopolitical conditions [115, 64]. In Sections 3.2.1 and 4.2, we address source and content bias, belief updating, affective partisan polarization, and the equilibrium outcomes given the online news market model.

3 Model

We build an extended game model based on [5] and [91]. The model consists of three news consumers with left (L), centrist (C), and right (R) political alignments and three news providers[5] (N, P_L, P_R). News providers P_L and P_R post news that are *framed* towards left and right partisan preferences, respectively [32]. In contrast, provider N attempts to maintain neutrality by presenting both left- and right-aligned information within a news item, and we model this as a linear combi-

[5]We consider duopoly scenarios in Online Appendix L and all results hold.

nation of left- and right-aligned information, which can vary in quality.

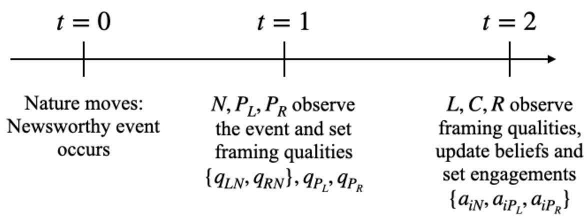


Figure 1: Extended Game Model Involving News Providers N, P_L and P_R Setting Framing Qualities $\{q_{LN}, q_{RN}\}, q_{P_L}, q_{P_R}$ to Drive Consumer Engagement from Consumers L, C and R

Figure 1 shows an extensive game that begins with nature moving to cause a newsworthy event (Stage 0). Next, the news providers N, P_L, and P_E each post a news item related to the event with different framing qualities (Stage 1). Consumers L, C, and R observe the framing qualities, update their beliefs and set their engagement levels (Stage 2). In Subsections 3.1 and 3.2, we describe the problems of news providers and consumers given the extensive game setup. In the remainder of this paper, we will use i to denote consumers $\{L, R, C\}$, j for news websites $\{N, P_L, P_R\}$, and i' to specifically refer to partisan consumers $\{L, R\}$.

3.1 News Providers' Problem

In Stage 1, news providers N, P_L and P_R simultaneously aim to maximize their profits by setting the framed qualities $q_{i'N}$ and $q_{P_{i'}}$ ($i' \in \{L, R\}$), anticipating engagement levels a_{iN}, a_{iP_L} and a_{iP_R} of consumers $i \in \{L, C, R\}$ in Stage 2. Provider N sets two quality levels emphasizing *neutral framing*. In contrast, P_L and P_R each set one quality level aligned with their partisan leanings following *emphasis framing*. Framing helps news websites maximize payoffs by boosting online engagement and increasing ad-driven income. Advanced tools (e.g., NLP, generative AI) aid journalistic efforts in setting such qualities but at the cost of primary data collection and analysis (e.g., interviews and surveys), investigative reporting overheads (e.g., travel), and web page design [100, 120]. We assume these costs are convex and increasing in quality [45]. Hence, news provider

N solves optimization problem (1), and P_L and P_R solve optimization problem (2) to maximize π_N, π_{P_L} and π_{P_R} respectively. In both problems, r_j is the marginal revenue from engagement, and k_j is the marginal cost of setting framing quality for each news provider.

$$\underset{q_{LN},q_{RN}}{\text{maximize}}\ \pi_N = r_N(\sum_{i\in\{L,C,R\}} a_{iN}) - k_N(\sum_{i'\in\{L,R\}} q^2_{i'N}), \quad \text{subject to } q_{i'N} \in \mathbb{R}_{\geq 0}, i' \in \{L, R\}. \tag{1}$$

$$\underset{q_{P_{i'}}}{\text{maximize}}\ \pi_{P_{i'}} = r_{P_{i'}}(\sum_{i\in\{L,C,R\}} a_{iP_{i'}}) - k_{P_{i'}}(q^2_{P_{i'}}), \quad \text{subject to } q_{P_{i'}} \in \mathbb{R}_{\geq 0}, i' \in \{L, R\}. \tag{2}$$

3.2 News Consumers' Problem

In Stage 2, consumers i, endowed with finite attention (normalized to 1) distributed across N, P_L and P_R, update their beliefs and decide on engagement levels $a_{iN}, a_{iP_L}, a_{iP_R} \in \mathbb{R}_{\geq 0}$. While consumers' attention and engagement levels are often correlated, our model's flexible structure allows us to capture various relationships between attention and engagement. This is important, as news interest, attention, and engagement intensity are only sometimes related to time spent on the news website [72]. Additionally, internet users rapidly consume large volumes of information using visual aids and signals, such as movies, graphics, and animations [131]. Therefore, we assume attention is an exogenous and finite resource, a fraction $\varphi_{iN} \in (0, 1)$ of which consumer i assigns to the neutral source N and the rest $(1 - \varphi_{iN})$ is allocated between P_L (φ_{iP_L}) and P_R (φ_{iP_R}) such that $\sum_{j\in\{N,P_L,P_R\}} \varphi_{ij} = 1$ for each consumer $i \in \{L, C, R\}$.

Given $\varphi_{ij} \in (0, 1)$, consumer i chooses engagement levels a_{ij} on each website j. This general structure allows us to analyze interior (inclusive) and corner (exclusive) cases where: (i) *Inclusive Consumption*: all consumers have non-zero attention proportions on all news websites. (ii) *Exclusive Consumption*: some consumers do not consume from some websites, e.g., a left-leaning partisan consumer (L) might not pay any attention to the neutral and right-leaning news sources ($\varphi_{iP_N} = \varphi_{iP_R} = 0$). In contrast, a centrist consumer (C) may only pay attention to the neutral news source ($\varphi_{CN} = 1$). We focus our analysis in the paper on inclusive consumption, discuss the results for exclusive consumption in Online Appendix Section L, and present the industry implications for both scenarios in Section 6. Next, we discuss how we model cognitively sophisticated consumers that hold and update beliefs regarding *source* vs. *content* neutrality of N, P_L and P_R.

Specifically, ex-ante with probability γ_N, consumers believe that N's posted news items are neutral. Conversely, ex-ante with probability $\gamma_{P_{i'}}$ consumers believe that $P_{i'}$'s news items are i'-aligned ($i' \in \{L, R\}$). Further, if consumers perceive N's posted news item as neutral, they believe N is neutral without any possibility of being left- or right-aligned due to confirmation bias; if they perceive the news item as biased, they still believe N is neutral with $\beta_N \in (0, 1)$ probability due to falsification bias. Similarly, if consumers perceive $P_{i'}$'s posted news item as i'-aligned, they believe $P_{i'}$ is i'-aligned without any possibility of being neutral (due to confirmation bias). On the other hand, if they perceive the news item as neutral, they still believe $P_{i'}$ is i'-aligned with $\beta_{P_{i'}} \in (0, 1)$ probability (due to falsification bias).

After N and $P_{i'}$ simultaneously post news items with qualities $\{q^*_{LN}, q^*_{RN}\}$ and $q^*_{P_{i'}}$ respectively in Stage 1, consumers update their beliefs and choose their engagement levels $a_{ij}, i \in \{L, C, R\}, j \in \{N, P_L, P_R\}$ in Stage 2. As we discussed in Section 2.3, we employ Bayesian updating to model the consumers' cognitive processing of news bias. Therefore after observing the posted news items, consumer $i \in \{L, C, R\}$ believes that N's news item is objective with probability $\sigma_N = \frac{\gamma_N}{(\gamma_N + (1-\gamma_N)(\beta_N))}$, and that $P_{i'}$'s news item is biased with probability $\sigma_{P_{i'}} = \frac{\gamma_{P_{i'}}}{(\gamma_{P_{i'}} + (1-\gamma_{P_{i'}})(\beta_{P_{i'}}))}$. Online Appendix Section D provides a short note on the derivation of these updated beliefs.

The baseline valuation v of news provides consumption utility. To avoid trivial corner cases where consumer engagement is zero, we assume $v > 1$. Consumers also face search costs when accessing each news website, attributed to factors such as readability, display, and format. We denote these costs for consumer $i \in \{L, C, R\}$ by $c_{iN}, c_{iP_L}, c_{iP_R}$, and allow these costs to vary between N, P_L and P_R. Compared to neutral websites, biased news websites might be relatively easier to navigate. This is because neutral websites offer more comprehensive and nuanced information, which can necessitate greater effort to navigate [116].

We incorporate these notions by normalizing $c_{iN} = 1$ and allowing the search costs on P_L and P_R to be lower than those on N ($0 < c_{iP_L} \leq 1, 0 < c_{iP_R} \leq 1$). Moreover, consumers L and R intuitively incur higher search costs on oppositely aligned partisan websites P_R and P_L, respectively. Therefore, we assume $c_{LP_L} < c_{LP_R} = 1$ and $c_{RP_R} < c_{RP_L} = 1$. Setting some search costs to one is to simplify the model and reduces the number of parameters and does not alter the main model insights. Relatedly, consumer C is assumed to incur the same search cost, $c_{CP} \in (0, 1)$, across L and R, i.e., $c_{CP_L} = c_{C_{P_R}} = c_{CP}$. In Sections 3.2.1 and 3.2.2 below, we will describe partisan polarization-driven utilities for L and R, and C, respectively.

3.2.1 Polarized Consumers' Decision Model

As discussed earlier, social-identity-driven affective polarization is how strongly people feel attached to one political group and opposed to the other [57]. To model affective polarization, we account for consumers' benefit from an affinity for their party and disutility from aversion to the other party. Formally, for polarized consumer i' consuming news on outlet j, $\hat{\mu}^{\text{aff}}_{i'j} > 0$ captures the consumer's affinity for aligned partisan information and $\hat{\mu}^{\text{ave}}_{i'j} > 0$ captures the consumer's aversion to rival partisan information. For instance, if $\hat{\mu}^{\text{aff}}_{i'j}$ (or $\hat{\mu}^{\text{ave}}_{i'j}$) is high, it implies that consumer i' has a strong affinity (or aversion) for partisan (or rival partisan) information when on website j.

Following [30], we incorporate partisan preferences (i.e., likes/dislikes) when modeling affinity or aversion. We define $\hat{\mu}^{\text{aff}}_{i'j} = \alpha_{i'} + \epsilon_j$ and $\hat{\mu}^{\text{ave}}_{i'j} = \alpha_{i'}$ where $\alpha_{i'} \in (0,1)$ can be interpreted as the degree of affective polarization which denotes consumer i''s partisan preference, while $\epsilon_j \in (0,1)$ denotes the difference between in-party affinity vs. out-party aversion on the website j. For instance, right-leaning consumers (R) may rationalize their party leaning when consuming news on N. Yet, on a partisan website (P_R), consumers R exclusively express strong likes without rationalization. Accordingly, we assume affinity dominates aversion[6] on the neutral outlet N ($\hat{\mu}^{\text{aff}}_{i'N} > \hat{\mu}^{\text{ave}}_{i'N}$) and for simplicity, set $\epsilon_N = 1$. Thus we have $\hat{\mu}^{\text{aff}}_{i'N} = 1 + \alpha_{i'}$ and $\hat{\mu}^{\text{ave}}_{i'N} = \alpha_{i'}$. Conversely, on partisan websites $P_{i'}, P_{-i'}$, we assume that consumers' degrees of affinity and aversion are comparable, i.e., $\epsilon_{P_{i'}} = 0$ such that $\hat{\mu}^{\text{aff}}_{i'P_{i'}} = \hat{\mu}^{\text{ave}}_{i'P_{-i'}} = \alpha_{i'}$. Therefore, the utility maximization problem for polarized consumer $i' \in \{L, R\}$ can be defined as follows.

$$
\begin{aligned}
\underset{a_{i'N}, a_{i'P_L}, a_{i'P_R}}{\text{maximize}} \quad & \sum_{j \in \{N, P_L, P_R\}} \varphi_{i'j} u_{i'j}, \qquad (3)\\
\text{subject to} \quad & u_{i'N} = (v + (1 - \sigma_N)(\hat{\mu}^{\text{aff}}_{i'N}(q_{i'N}) - (\hat{\mu}^{\text{ave}}_{i'N})(q_{-i'N})))a_{i'N} - c_{i'N} a^2_{i'N},\\
& u_{i'P_{i'}} = (v + \sigma_{P_{i'}} \hat{\mu}^{\text{aff}}_{i'P_{i'}} q_{P_{i'}}) a_{i'P_{i'}} - c_{i'P_{i'}} a^2_{i'P_{i'}},\\
& u_{i'P_{-i'}} = (v - \sigma_{P_{-i'}} \hat{\mu}^{\text{ave}}_{i'P_{-i'}} q_{P_{-i'}}) a_{i'P_{-i'}} - c_{i'P_{-i'}} a^2_{i'P_{-i'}}\\
& a_{i'N}, a_{i'P_L}, a_{i'P_R} \in \mathbb{R}_{\geq 0}, \forall\, i', -i' \in \{L, R\}, i' \neq -i'.
\end{aligned}
$$

The objective function in (3) models the overall news consumption utility that consumer i' derives from consuming news on $j \in \{N, P_L, P_R\}$ weighted by the attention parameters $\varphi_{i'j}$. In addition to the baseline utility v, with $1 - \sigma_N$ probability, consumers believe N's news item is *not* objective and accordingly derive utility, and incur disutility $(\hat{\mu}^{\text{aff}}_{i'}(q_{i'N}) - (\hat{\mu}^{\text{ave}}_{i'})(q_{-i'N}))$ from partisan framing

[6]We consider the scenario where aversion dominates affinity in the Online Appendix, Subsection L.4, and provide implications in Section 6.

of the news. Similarly, with $1-\sigma_{P_{i'}}$ probability, consumers believe $P_{i'}$'s news item is objective and only enjoy the basic valuation v. However, with $\sigma_{P_{i'}}$ probability, they believe the news item is i'-partisan and thus, in addition to v, derive utility $\sigma_{P_{i'}}\alpha_{i'}q_{P_{i'}}$ (due to *affinity*) or incur disutility $\sigma_{P_{-i'}}\alpha_{i'}q_{P_{-i'}}$ (due to *aversion*) depending on consumer i''s own partisan alignment.

3.2.2 Centrist Consumers' Decision Model

In line with [5, 52], we assume that the centrist consumer, C, is bipartisan, appreciates objectivity, and consequently experiences no aversion while on N. However, while on the partisan website $P_{i'}$, the centrist consumer incurs disutility due to aversion to partisan news.[7] To characterize C's affective polarization parameters, $\hat{\mu}_{Cj} = \alpha_C + \epsilon_j$, we note that C has a stronger preference for bipartisan news compared to partisan consumers L and R. For simplicity, we thus set $\alpha_{CN} = \alpha_{CP_L} = \alpha_{CP_R} = 1 > \alpha_{i'}, i' \in L, R$ and $\epsilon_N = 0$. On partisan websites $P_{i'}$, we assume that C exhibits likes and dislikes to partisan news similar to L, R such that $\epsilon_{P_{i'}} = 0$. Accordingly, we characterize consumer C's utility maximization problem below:

$$
\begin{aligned}
\underset{a_{CN},a_{CP_L},a_{CP_R}}{\text{maximize}} \quad & \sum_{j\in\{N,P_L,P_R\}} \varphi_{Cj}u_{Cj}, \\
\text{subject to} \quad & u_{CN} = (v+(1-\sigma_N)(\alpha_{CN})(q_{LN}+q_{RN}))a_{CN} - c_{CN}a_{CN}^2, \\
& u_{CP_{i'}} = (v-\sigma_{P_{i'}}\alpha_{CP_{i'}}q_{P_{i'}})a_{CP_{i'}} - c_{CP_{i'}}a_{CP_{i'}}^2 \\
& a_{CN}, a_{CP_L}, a_{CP_R} \in \mathbb{R}_{\geq 0}.
\end{aligned}
\tag{4}
$$

In our main model, we focus on pure centrist consumers, C, who engage in inclusive consumption across the three news websites N, P_L and P_R, based on observed framing quality levels. Accordingly, we make the following assumptions about the search costs $c_{i'P_L}$ and $c_{i'P_R}$, and marginal

[7] In Online Appendix L, we explore an extension that includes center-adjacent (-left or-right) consumers instead of pure centrist consumers.

Table 1: List of All Parameters and Decision Variables and Outcomes Used in the Model

Indices	
Index for all consumers	$i \in \{L, C, R\}$
Index for all news websites	$j \in \{N, P_L, P_R\}$
Index for partisan consumers	$i' \in \{L, R\} \subset \{L, C, R\}$
Parameters	
Base news valuation for all consumers	$v > 1$
Marginal revenue from consumer engagement	$r_j \in \mathbb{R}_{\geq 0}$
Marginal costs of setting quality levels	$k_j \in \mathbb{R}_{\geq 0}$
Proportion of attention given to the neutral website N	$\varphi_N \in (0, 1)$
Consumers' ex-ante prior beliefs regarding news item's neutrality or bias on N and $P_{i'}$	$\gamma_j \in (0, 1)$.
The probability consumers believe N is neutral, given consumers perceive N's posted news item is biased	$\beta_N \in (0, 1)$
The probability consumers believe $P_{i'}$ is i'-aligned, given consumers perceive $P_{i'}$'s posted news item is neutral	$\beta_{P_{i'}} \in (0, 1)$
Ex-post consumers' updated beliefs regarding news item neutrality or bias on N and $P_{i'}$	$\sigma_j \in (0, 1)$
Search costs for consumers on the neutral website N	$c_{iN} \in \mathbb{R}_{\geq 0}$
Search costs for consumers on the partisan website $P_{i'}$	$c_{iP_{i'}}, c_{iP_{-i'}} \in \mathbb{R}_{\geq 0}$
The degree of political polarization for consumers	$\alpha_i \in (0, 1)$
Difference between consumers' in-party affinity and out-party aversion on j	$\epsilon_j \in \mathbb{R}$
Decision Variables	
Partisan news information quality levels	$q_{i'N}, q_{P_{i'}}$
Engagement levels on websites j decided by consumers i	a_{ij}
Equilibrium Outcomes	
Consumption utility for consumers i on news websites j	u_{ij}
Payoffs for news websites j	π_j

revenues and costs on P_L and P_R: (1) $c_{i'P_{i'}} \in \left(0, \frac{c_{CP}\alpha_{i'}}{1+c_{CP}\alpha_{-i'}}\right)$, meaning that partisan consumers' search costs on the similarly aligned partisan website is bounded from above and cannot be too high. (2) $\frac{r_{P_{i'}}}{k_{P_{i'}}} \in \left(0, \frac{4c_{CP}c_{i'P_{i'}}}{\sigma_{P_{i'}}(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'}+1))}\right)$, $-i' \in \{L, R\}, i' \neq -i'$, which is to ensure that partisan websites cannot cover the entire market. The analyses of other equilibria are presented in the Online Appendix, Section L. However, while discussing the implications in Section 6, we address these additional scenarios.

4 Equilibrium Analysis

We use backward induction and begin the analysis in Stage 2. Specifically, given framing quality levels q^*_{LN}, q^*_{RN} and $q^*_{P_{i'}}$, consumer i updates her beliefs regarding the neutrality or bias of the news items and sets optimal engagement levels a_{iN}, a_{iP_L} and a_{iP_R} to maximize her utility. We begin by characterizing the equilibrium quality setting responses of news websites N, P_L and P_R and engagement setting by consumers L, C and R in Lemma 1 below.

Lemma 1. *The equilibrium values of news qualities and consumer engagement levels are characterized by the expressions in Table 2 (where, $i', -i' \in \{L, R\}, i' \neq -i'$).*

Table 2: Optimal Framing Qualities and Engagement Levels in the Inclusive Consumption Oligopoly Equilibrium

	Variable	**Equilibrium Value**
Websites	$q^*_{i'N}$	$\frac{r_N}{k_N}\left(\frac{(1-\sigma_N)(2+(\alpha_{i'}-\alpha_{-i'}))}{4}\right)$
N, P_L, P_R	$q^*_{P_{i'}}$	$\frac{r_{P_{i'}}}{k_{P_{i'}}}\left(\frac{\sigma_{P_{i'}}(c_{CP}\alpha_{i'}-c_{i'P_{i'}}(c_{CP}\alpha_{-i'}+1))}{4c_{CP}c_{i'P_{i'}}}\right)$
Partisan	$a^*_{i'N}$	$\frac{1}{2}\left(v+\frac{r_N}{k_N}\left(\frac{\sigma_N^2\left(2+(\alpha_{i'}-\alpha_{-i'})(1+2\alpha_{i'})\right)}{4}\right)\right)$
Consumers	$a^*_{i'P_{i'}}$	$\frac{1}{2c_{i'P_{i'}}}\left(v+\frac{r_{P_{i'}}}{k_{P_{i'}}}\left(\frac{\alpha_{i'}\sigma^2_{P_{i'}}(c_{CP}\alpha_{i'}-c_{i'P_{i'}}(c_{CP}\alpha_{-i'}+1))}{4c_{CP}c_{i'P_{i'}}}\right)\right)$
L, R	$a^*_{i'P_{-i'}}$	$\frac{1}{2}\left(v-\frac{r_{P_{-i'}}}{k_{P_{-i'}}}\left(\frac{\alpha_{i'}\sigma^2_{P_{-i'}}(c_{CP}\alpha_{-i'}-c_{P_{-i'}}(c_{CP}\alpha_{i'}+1))}{4c_{CP}c_{P_{-i'}}}\right)\right)$
Centrist	a^*_{CN}	$\frac{1}{2}\left(v+\frac{r_N\sigma_N^2}{k_N}\right)$
Consumer C	$a^*_{CP_{i'}}$	$\frac{1}{2c_{CP}}\left(v-\frac{r_{P_{i'}}}{k_{P_{i'}}}\left(\frac{\sigma^2_{P_{i'}}(c_{CP}\alpha_{i'}-c_{i'P_{i'}}(c_{CP}\alpha_{-i'}+1))}{4c_{CP}c_{i'P_{i'}}}\right)\right)$

Proofs are provided in Online Appendix E. Typically, polarization influences how journalists report events given media reputations [106]. Journalists can reduce partisan influence and provide fair, balanced, and accurate news coverage by using objectivity, according to research [98]. However, Lemma 1 suggests that competition for engagement can incentivize news websites to exploit such polarization. For example, when consumer L has stronger affective polarization for partisan news than R ($\alpha_L > \alpha_R$), left-aligned information quality is set higher than right-aligned information quality ($q^*_{LN} > q^*_{RN}$).

We also note that equilibrium engagement levels do not necessarily rise with an improvement in partisan news quality; rival partisan news must also be considered. Essentially, changes in engagement levels are determined by improvements in quality relative to rival partisan news. Moreover, equilibrium $a^*_{i'N}$ and $a^*_{i'P_{i'}}$ reveal that engagement is driven by relative polarization levels. For example, when L has a higher affinity for partisan news than R (i.e., $\alpha_L - \alpha_R > 0$), L's engagement level on N is greater than R (i.e., $a^*_{LN} > a^*_{RN}$). Further, polarization and website-specific search cost $c_{i'P_{i'}}$ impact engagement levels on $P_{i'}$ for partisan and centrist consumers, which is aligned with empirical and anecdotal evidence [90].

4.1 Partisan Framing Competition

In order to analyze the equilibrium comparative statics of competition between news websites, we first define the following measure to compare the qualities set by N, P_L and P_R:

Definition 1. ***Competitive Partisan Framing****: We define $\Delta_{j,-j}$ for $j \in \{N, P_L, P_R\}$ as a measure of competitive partisan framing qualities $\{q_{i'N}, q_{P_{i'}}\}$ set by news websites $j \in \{N, P_L, P_R\}$ for partisan consumers $i' \in \{L, R\}$ such that:*

$$\Delta_{j,-j} = \begin{cases} q^*_{P_{i'}} - q^*_{i'N}, & j = P_{i'}, -j = N, \\ q^*_j - q^*_{-j}, & j, -j \in \{P_L, P_R\}, j \neq -j. \end{cases}$$

By definition, $\Delta_{j,-j}$ measures competition between N, P_L and P_R using the relative difference in partisan framing qualities. For example, a positive $\Delta_{P_L,N}$ suggests P_L sets a higher $q^*_{P_L}$ than q^*_{LN} to engage left-leaning consumers when competing with N. Generally, low (high) $\Delta_{j,-j}$ values suggest websites have set similar (dissimilar) framing qualities. Utilizing advanced technology tools, cognitive reapportionment of journalistic responsibilities can boost reporting quality competition [11, 28]. Indeed, news organizations have utilized political discourse similarities to influence viewers online and offline [12, 23]. Recent research has found differences in partisan framing of COVID-19 messaging online [126]. However, the marginal costs (k_j) incurred against the revenue (r_j) realized from setting such qualities determine *how* companies can compete. Lemma 2 characterizes the values of competitive partisan framing measures, $\Delta_{j,-j}$, in equilibrium.

Lemma 2. *Suppose that a news website's marginal profitability is gauged using the marginal* *returns-to-cost (MRC) ratio,* $\mathrm{MRC}_j = \frac{r_j}{k_j}$*. Then, neutral and partisan websites set equilibrium framing qualities such that:*

I. $\Delta_{P_{i'},N} < 0$ *only when* $\frac{MRC_N}{MRC_{P_{i'}}} \geq \Theta_1$*,*

II. $\Delta_{P_{i'},P_{-i'}} > 0$ *only when* $\frac{MRC_{P_{i'}}}{MRC_{P_{-i'}}} \geq \Theta_2$*,*

where $\Theta_1 = \frac{\sigma_{P_{i'}}}{1-\sigma_N}\left(\frac{c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'}+1)}{c_{CP}c_{i'P_{i'}}(2+\alpha_{i'}-\alpha_{-i'})}\right)$, $\Theta_2 = \frac{\sigma_{P_{-i'}}}{\sigma_{P_{i'}}}\left(\frac{c_{i'P_{i'}}(c_{CP}\alpha_{-i'} - c_{-i'P_{-i'}}(c_{CP}\alpha_{i'}+1))}{c_{-i'P_{-i'}}(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'}+1))}\right)$.

The proof is in Online Appendix F. Lemma 2 reveals that websites accentuate partisan alignment due to MRC values, increasing framing disparities. Specifically, N may dominate $P_{i'}$ ($\Delta_{P_i,N} < 0$) or one partisan website might dominate another ($\Delta_{P_{i'},P_{-i'}} > 0$) if the ratio of MRC values of the dominant website surpasses thresholds Θ_1 or Θ_2. These thresholds, which can be high (≥ 1) or low (< 1), are determined by various factors, crucial among which is the *updated* belief likelihood ratios ($\frac{\sigma_{P_{i'}}}{1-\sigma_N}$ for Θ_1 and $\frac{\sigma_{P_{-i'}}}{\sigma_{P_{i'}}}$ for Θ_2). Lemma 2 shows that ceteris paribus, *updated* beliefs of neutrality or bias can increase competitive partisan framing in a way that incentivizes one website to frame news with greater partisan lean even when its MRC may be altogether lower (e.g., $MRC_j < MRC_{-j}$) but higher than a threshold (e.g., $\frac{MRC_j}{MRC_{-j}} \geq \Theta_2$, where $\Theta_2 \in (0, 1)$) relative to the competitor. Thus, the online news market exploits consumer perceptions to maximize engagement-driven revenues.

However, a comprehensive analysis of competitive partisan framing must consider the impact of changes in affective polarization (i.e., $\frac{\partial \Delta_{j,-j}}{\partial \alpha_{i'}}$) and search costs (i.e., $\frac{\partial \Delta_{j,-j}}{\partial c_{i'P_{i'}}}$). Generally, technology-driven cognitive reapportionment can impact the strategic behavior of firms [67, 34]. Indeed, news organizations can influence competitive framing by changing the website design or news suggestions. Still, increasingly polarized consumers may engage more with partisan than neutral websites [42]. Thus, how polarization, consumer beliefs, search costs, and MRC interact to influence competitive framing strategies are unclear [74]. Proposition 1 aims to shed light on this complex interplay of factors.

Proposition 1. *An increase in i'-leaning polarization ($\alpha_{i'}$, $i' \in \{L, R\}$) impacts competitive framing between partisan and neutral websites such that $\Delta_{P_{i'},N}$ decreases and $\Delta_{P_{-i'},N}$ increases only when N has relatively higher MRC than both $P_{i'}$ and $P_{-i'}$. Likewise, an increase in centrist consumers' search costs on partisan websites (c_{CP}) impacts competitive partisan framing between the partisan websites such that $\Delta_{P_{i'},P_{-i'}}$ increases only when $P_{i'}$ has relatively higher MRC than $P_{-i'}$.*

The proof is in Online Appendix G. Extending Lemma 2, Proposition 1 shows that N modulates framing qualities for engaging L or R consumers, while P_L and P_R, enjoying loyal engagement from partisan consumers L and R respectively, also compete over engaging the centrist consumer. Intuitively, changes in search prices or polarization may drive neutral and partisan news websites to improve quality to attract consumer engagement. However, Proposition 1 shows that the outcome depends on relative MRC values and updated belief comparisons on neutrality or bias between competing websites.

In general, an increase in consumer L's polarization should incentivize P_L to appear more partisan (increase $q^*_{P_L}$), P_R to appear less partisan (decrease $q^*_{P_R}$) and N to appear less biased (decrease q^*_{LN}, q^*_{RN}) towards L, thereby increasing $\Delta_{P_L,N}$ and decreasing $\Delta_{P_R,N}$. Yet, competition for engagement between N, P_R and P_L suggests otherwise. An increase in L's polarization implies N can marginally increase q^*_{LN} and decrease q^*_{RN} at a greater rate than increase in $q^*_{P_L}$ or decrease in $q^*_{P_R}$. This holds even when P_L and P_R have higher MRCs than N. Intuitively, when N enjoys a higher MRC than P_L, P_R, then revenue-maximization incentivizes marginal increases in q^*_{LN}, marginal decrease in q^*_{RN} over $q^*_{P_L}, q^*_{P_R}$ that engages partisan consumers. However, if consumers strongly believe in N's vs. P_L's bias ($\left(\frac{\sigma_{P_L}}{1-\sigma_N}\right) \leq 1$), experience high search costs on P_L ($\left(\frac{\sigma_{P_L}}{(1-\sigma_N)c_{P_L}}\right) < 1$) then even if P_L has a higher MRC than N ($MRC_N < MRC_{P_L}$), N may have a relatively higher MRC such that $\frac{MRC_N}{MRC_{P_L}} \geq \left(\frac{\sigma_{P_L}}{(1-\sigma_N)c_{P_L}}\right)$. Thus, N marginally increases q^*_{LN} more than $q^*_{P_L}$ and marginally decreases q^*_{RN} more than $q^*_{P_R}$, not only engaging L but also exploiting C's bipartisan preference.

From a partisan website's perspective, Proposition 1 shows that a centrist consumer's consumption is crucial to competitive partisan framing. While increasing search costs $c_{i'P_{i'}}$ incentivizes $P_{i'}$ to increase $q^*_{P_{i'}}$, the centrist consumer C's engagement on $P_{i'}$ also matters in determining *how much* framing qualities need to be increased. In general, if C experiences high search costs on partisan websites (high c_{CP}), then partisan websites can marginally decrease framing quality $q^*_{P_{i'}}$ to engage C. But by decreasing qualities, they risk losing engagement from partisan consumers L, R. Indeed, MRC comparisons ultimately determine marginal changes to partisan framing qualities. For instance, if P_L enjoys a greater MRC than P_R then marginal increase in $q^*_{P_L}$ dominates the decrease in $q^*_{P_R}$. But if P_R is perceived as less partisan than P_L ($\frac{\sigma_{P_R}}{\sigma_{P_L}} < 1$), then even when P_L enjoys a lower MRC than P_R ($MRC_{P_L} < MRC_{P_R}$), P_L may have a *relatively* greater MRC compared to P_R $\left(\frac{MRC_{P_L}}{MRC_{P_R}} \geq \left(\frac{\sigma_{P_R}}{\sigma_{P_L}}\right)\right)$ that can incentivize marginal increase in $q^*_{P_L}$ greater than decrease in $q^*_{P_R}$. In essence, P_R exploits C given the prevailing perception about it being less partisan, while P_L exploits the aligned partisan consumer L.

Online news competition allows digital product sellers to use differentiation to exploit consumer demand [9]; political framing qualities increase engagement across neutral or partisan websites by polarizing consumers. Proposition 1 suggests competitive framing can drive neutral and partisan websites to capitalize on polarization and centrist consumers. Partisan framing quality improvements can promote engagement competition as cognitive reapportionment decreases journalistic production costs. However, differentiated best responses and the impact of aggressive differentiation strategies on payoffs are important tests of competition intensity [63]. While Proposition 1 focused on competitive partisan framing and its implications, Proposition 2 discusses how changes in polarization impact the payoffs of N and $P_{i'}$ ($i' \in \{L, R\}$).

Proposition 2. *The neutral outlet's payoff (π_N^*) is contingent upon polarization asymmetry* $(\alpha_{i'} - \alpha_{-i'})$. *Meanwhile, the partisan outlets' payoffs ($\pi_{P_{i'}}^*$) increase with aligned polarization ($\alpha_{i'}$), and are negatively affected when the opposite-aligned polarization ($\alpha_{-i'}$) rises.*

The proof is in Online Appendix H. Proposition 2 reveals that neutral news outlets' incentives depend on an unequally polarized consumer base [118]. For ease of illustration, we refer to $(\alpha_{i'} - \alpha_{-i'})$ as polarization asymmetry. Therefore, if $\alpha_{i'} \geq \alpha_{-i'}$, polarization asymmetry is non-negative. From Lemma 1, it follows that a non-negative polarization asymmetry implies $q_{i'N}^* \geq q_{-i'N}^*$. Now if $\alpha_{i'}$ increases, it leads to higher polarization asymmetry, which according to Lemma 1, leads to an increase in $q_{i'N}^*$ and a decrease in $q_{-i'N}^*$. Given partisan consumers' disutility from opposite-partisan information and centrist consumers' bipartisan affinity, increasing $q_{i'N}^*$ increases i' partisan and centrist consumers' engagement, decreases $-i'$ consumers' already low engagement, and increases π_N^*. Conversely, if $\alpha_{-i'}$ increases, then polarization asymmetry decreases. While a resulting increase in $q_{-i'N}^*$ increases engagement from $-i'$ and C, it decreases engagement from the highly engaged i'. In aggregate, the revenue loss from the highly engaged i' offsets any gains from the relatively lower engaged $-i'$.

Our results can help explain some of the recent developments in the online news environment. Growing polarization and political information fragmentation have affected news consumers' preferences for online news [97]. First, more polarized partisan environments have seen rising engagement on online news websites that promise bipartisan and unbiased news, making them more visible and more likely to be used by the broader user base [47, 129, 83]. Second, as trust in news media is lower in highly polarized partisan environments, consumers are less likely to identify as "mainstream" media users and more likely to use alternative news sources (e.g., online news websites) [18]. These two factors partly explain the increased online engagement on some perceived neutral news websites such as Reuters or AP News [129] and partisan websites (e.g, The Daily Caller, Vox) [56].

More recently, a 2022 Reuters-Oxford Digital News Report [107] states that despite rising affective polarization and increasing access to online partisan news, more than 50% of their respondents across Europe, the US and Canada prefer journalists to report facts rather than partisan posturing. Distrust of mainstream media has inspired interest in online news, but partisan polarization remains stable mainly (in the short run), and lesser-known partisan sites have had little influence [107]. Neutral news sources are therefore primed to increase engagement by presenting facts and bipartisan-flavored news that may sometimes emphasize one partisan framing [20]. Indeed, a recent analysis by Fractl suggests a steady rise in site visits by consumers on 'reliable' websites[8] (i.e., APNews, Reuters, NPR) after the highly polarizing 2020 US Election [83]. Thus, as Proposition 2 suggests, neutral news outlets have an opportunity to engage partisans in a polarized environment better.

4.2 Partisan Consumer Engagement

In this section, we analyze the impact of framing qualities on consumer engagement levels moderated by consumer beliefs and affective polarization. For ease of exposition, we define the following cognitive tendencies, derived from the standard leveling vs. sharpening theory [54, 41, 53], associated with belief updates captured by $\sigma_j, j \in \{N, P_L, P_R\}$.

Definition 2. *Given content neutrality priors (γ_j) and source vs. content falsification biases (β_j):*

1. ***Leveling Tendency**: When consumers' prior beliefs in N's content neutrality and $P_{i'}$'s content bias increase, they become increasingly convinced that news items from N are objective and those from $P_{i'}$ are partisan.*

[8]Ad Fontes Media's reliability rating ranges from $0 - 64$ for fact reporting to analysis, opinion, propaganda, and inaccurate/fabricated material. High scores are for factual and non-partisan reporting.

2. ***Sharpening Tendency**: When consumers' falsification biases towards N's neutrality (β_N) or $P_{i'}$'s partisan bias ($\beta_{P_{i'}}$) increase, they become more likely to reject that N's news items are neutral or that $P_{i'}$'s are partisan.*

We begin our analysis by examining the impact of polarization on consumer engagement ($\frac{\partial a^*_{i'j}}{\partial \alpha_{i'}}$), before exploring the combined effects with cognitive tendencies– leveling ($\frac{\partial^2 a^*_{i'j}}{\partial \alpha_{i'} \partial \gamma_j}$) vs. sharpening ($\frac{\partial^2 a^*_{i'j}}{\partial \alpha_{i'} \partial \beta_j}$) – first for the neutral website N (in Proposition 3), and then for partisan websites $P_{i'}$ (in Proposition 4).

Proposition 3. *If both left and right partisan consumers' affective polarization levels are already relatively high (i.e., $\alpha_{-i'} \in \left(\frac{1}{2}, 1\right)$ and $\alpha_{i'} \in \left(\frac{\alpha_{-i'}}{2} - \frac{1}{4}, 1\right)$ for $i' \in \{L, R\}$), then as partisan consumer i' becomes more polarized (i.e., $\alpha_{i'}$ increases):*

I. Engagement level $a^*_{i'N}$ on N increases.

II. The rate of increase in engagement level $a^*_{i'N}$ increases with the sharpening tendency and decreases with the leveling tendency.

The proof is in Online Appendix I. Proposition 3 considers the question: *How do consumers change their engagement given strategic framing adjustments by N and $P_{i'}$?* The answer is not straightforward when there is competition between news providers. Based on Proposition 2, N's best response to P reveals an incentive to overemphasize one partisan side by exploiting consumers' bias vs. neutrality perceptions. Thus, given increasing polarization, engagement levels on N may not change monotonically.

Recall that polarization ($\alpha_{i'}, i' \in \{L, R\}$) has a first-order, 'double-edged sword' effect on engagement and a second-order effect on the quality set by N (Subsection 3.2.1). When one group of partisan consumers is less polarized than the other, N sets lower news quality for this group, according to Lemma 1. However, increasing polarization of that partisan consumer incentivizes N to improve the corresponding partisan quality (Proposition 1) which implies a rise in the increasingly polarized partisan consumer's engagement levels. Further, even when news is perceived as biased, sharpening tendency highlights N's neutrality. Thus, increasingly polarized partisan consumers engage more with a *perceived* neutral N serving news items aligned with their partisan identity L or R. Instead, leveling tendency highlights the neutrality of N's news item. Thus, increasingly polarized partisan consumers will avoid perceived non-partisan news, decreasing their engagement. These results could partly explain why some neutral outlets (e.g., PBS and NPR), which "dare to be boring," are losing online readership [103] while others (e.g., Reuters, BBC News) are gaining [105].

Experimental evidence in [86] helps contextualize these results, as they suggest consumers engage more with partisan-framed news on websites with a reputation as being impartial such as Reuters and BBC News. Importantly, trust in news sources' impartiality appears to drive such engagement. Surveys indicate that while complete neutrality may be seen as unattainable, engaged audiences in Europe and North America still consider it a defining feature of news [106, 107], and most respondents believe that journalists should provide facts in an objective and fair way instead of opinions. As a result, news items from brands known and trusted to deliver impartial news are popular (e.g., Reuters and BBC News are among the top 3 most trusted news brands worldwide [105]). At the same time, neutral websites utilize partisan framing to attract engagement (Proposition 1) which explains why some neutral websites, such as Reuters and BBC News, have faced accusations of partisan reporting and have seen a rise in popularity, while others, like PBS and NPR, are sometimes perceived as less engaging.

Proposition 4. *When partisan consumer $i' \in \{L, R\}$ becomes more polarized (i.e., $\alpha_{i'}$ increases) and search costs on $P_{-i'}$ are relatively high ($c_{-i'P_{-i'}} \in \left(\frac{c_{CP}\alpha_{-i'}}{1+2c_{CP}\alpha_{i'}}, \frac{c_{CP}\alpha_{-i'}}{1+c_{CP}\alpha_{i'}}\right)$):*

I. Engagement level $a^*_{i'P_{-i'}}$ on $P_{-i'}$ increases.

II. The rate of increase in engagement level $a^*_{i'P_{-i'}}$ increases with the leveling tendency and decreases with the sharpening tendency.

The proof is in Online Appendix J. In the context of partisan websites, it is intuitive that an increase in partisan polarization $\alpha_{i'}$ enhances engagement on the aligned website $P_{i'}$. However, engagement on opposite-aligned website $P_{-i'}$ does not increase unless the search costs on $P_{-i'}$ are high for $P_{-i'}$'s similarly aligned partisans $(-i')$. Search costs incorporate aspects such as news recommendation quality, which influences the ease with which news is discovered and consumed. Proposition 4 shows that under increasing polarization, high search costs can disrupt the usual 'echo-chamber', encouraging consumers also to seek information from the opposing side. For news providers, Proposition 4 underscores the importance of designing their news websites, focusing on lowering search costs for consumers.

Proposition 4 further provides insight into recent findings such as the Pew analysis of congressional e-newsletters [19]. This study found that The Wall Street Journal is most frequently utilized by Republican members, while The New York Times is more commonly used by Democratic members. Nevertheless, many members across the political spectrum source information from both these news outlets. Frequently cited reasons include perceptions of balanced reporting from liberal and conservative voices on both websites [113]. Further, The Washington Post's readership tends to be more liberal, but many Republicans have lately also preferred its digital edition [19].

Cognitive Dissonance Theory (CDT), one of the most recognized causes of selective exposure [59], offers a broader interpretation of Proposition 4. According to CDT, online consumption behavior is driven by (1) a strong preference for information that matches personal attitudes and (2) a strong aversion to information that does not [90]. Importantly, if these conditions hold, partisans would be more likely to choose sources that align with their partisan beliefs over moderate or neutral ones. However, high search costs can influence framing quality and consumer engagement. Specifically, high search costs on $P_{-i'}$ can reduce consumers' consumption utility, while an increasing polarization of consumer i' can lower the framing quality $q^*_{P_{-i}}$, leading to greater engagement from consumer i'. Yet, sharpening, which highlights the news item's partisan bias instead of the website's, can result in an increasingly polarized partisan i' engaging less with $P_{-i'}$'s and more with $P_{i'}$'s news item. Thus, sharpening tendencies can reduce engagement from increasingly polarized partisan consumers on rival-partisan websites with high search costs [127].

In summary, Propositions 3 and 4 offer analytical insights into the complex interplay of polarization, prior beliefs, and public perceptions in determining consumer engagement levels in the online news landscape. Westerwick et al. [125] provide empirical evidence of how online news outlets can *persuade* consumers towards partisan views, influenced by their prior beliefs regarding the source and news reporting. Our analysis aligns with this empirical evidence. We demonstrate that through the use of parameterized beliefs $\sigma_{i'}(\gamma_j, \beta_j), j \in N, P_{i'}$ and polarization $\alpha_{i'}, i' \in L, R$, along with a representation of consumption utility, cognitive tendencies (such as leveling vs. sharpening) can interact with polarization to influence engagement levels on online news websites, acting at times as complements and at others as substitutes, as demonstrated in Propositions 3 and 4.

5 Application: Framing Quality Elasticity

In this section, we introduce the elasticity measures $\eta_{Ni'} = \frac{a^*_{i'N}}{Q^*_N}\frac{\partial Q^*_N}{\partial a^*_{i'N}}, \eta_{i'P_{i'}} = \frac{a^*_{i'P_{i'}}}{q^*_{P_{i'}}}\frac{\partial q^*_{P_{i'}}}{\partial a^*_{i'P_{i'}}}$ and $\eta_{-i'P_{i'}} = \frac{a^*_{-i'P_{i'}}}{q^*_{P_{i'}}}\frac{\partial q^*_{P_{i'}}}{\partial a^*_{-i'P_{i'}}}$ where $Q^*_N = q^*_{i'N} - q^*_{-i'N},\ i' \in \{L, R\}$. These measures which we will refer to as *Engagement Elasticities of Partisan Framing Quality* measure the *responsiveness* of framing quality on N and $P_{i'}$ to changes in partisan consumer engagement L, R. The following theorem characterizes these elasticities.

Theorem 1. *At equilibrium, the following characterizes engagement elasticities of partisan framing* *quality* $(\eta_{Ni'}, \eta_{i'P_{i'}}, \eta_{-i'P_{i'}})$*:*

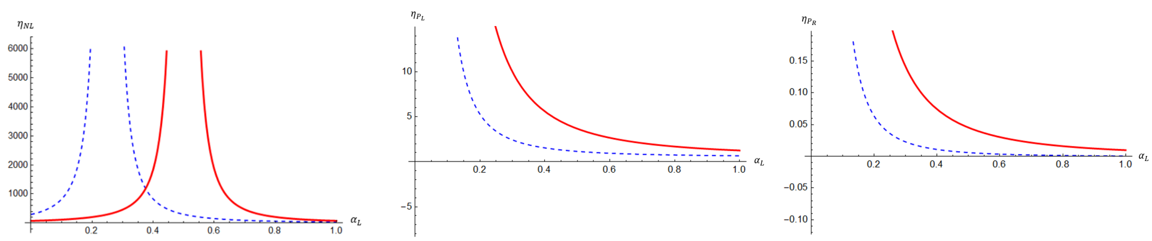
$$\eta_{Ni'} = \frac{1}{(\alpha_{i'} - \alpha_{-i'})^2}\left(\frac{vk_N}{r_N(1-\sigma_N)^2} + (4 + 2(1+2\alpha_{i'})(\alpha_{i'} - \alpha_{-i'}))\right),$$

$$\eta_{i'P_{i'}} = \frac{2c_{i'P_{i'}}c_{CP}}{2c_{CP}\alpha_{i'} - c_{i'P_{i'}}(1+2c_{CP}\alpha_{-i'})}\left(\alpha_{i'} - \frac{2k_{P_{i'}}vc_{CP}}{\sigma^2_{P_{i'}}r_{P_{i'}}(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(1+c_{CP}\alpha_{-i'}))}\right),$$

$$\eta_{-i'P_{i'}} = \frac{2c_{i'P_{i'}}c_{CP}}{2c_{CP}\alpha_{i'} - c_{i'P_{i'}}(1+2c_{CP}\alpha_{-i'})}\left(\alpha_{-i'} - \frac{2k_{P_{i'}}vc_{CP}c_{i'P_{i'}}}{\sigma^2_{P_{i'}}r_{P_{i'}}(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(1+c_{CP}\alpha_{-i'}))}\right),$$

where it follows that $\eta_{i'P_{i'}}, \eta_{-i'P_{i'}} \geq 0, \eta_{Ni'} \geq 0$ *for all* $\alpha_{i'}, \alpha_{-i'}, c_{i'P_{i'}}, c_{CP} \in (0,1)$ *and* $v > 1$.

The proofs are in Online Appendix K. If the values of engagement elasticities of partisan framing quality for N ($\eta_{Ni'}$) are close to zero, it implies that partisan engagement levels exert a negligible effect on the contrast between left- and right-partisan framing qualities within N. Conversely, higher values of $\eta_{Ni'}$ indicate a propensity towards divergent framing. Similarly, if the elasticity measures for the partisan websites ($\eta_{i'P_{i'}}$ or $\eta_{-i'P_{i'}}$) are close zero, it suggests that the engagement levels of partisan i' or $-i'$ consumers exert minimal influence on i'-partisan framing on $P_{i'}$. Specifically, a low value of $\eta_{-i'P_{i'}}$ implies that $P_{i'}$ has less concern for non-partisan consumers. Figure 2 provides illustrative examples of how elasticity values evolve as polarization changes.



(a) Elasticity $\eta_{Ni'}$ vs. α_L, where $\alpha_R = \{\frac{1}{4}$ (dotted) , $\frac{1}{2}$ (solid) $\}$

(b) Elasticity η_{LP_L} vs. α_L, where $\alpha_R = \{\frac{1}{4}$ (dotted) , $\frac{1}{2}$ (solid) $\}$

(c) Elasticity η_{RP_L} vs. α_L, where $\alpha_R = \{\frac{1}{4}$ (dotted) , $\frac{1}{2}$ (solid) $\}$

Figure 2: Analyzing changes in elasticities due to changes in polarization of L and R. Parameter values preserve the interior equilibrium (Lemma 1) and are: $v \to 2, k_N \to 1, k_{P_{i'}} \to 1, r_{P_{i'}} \to 1, c_{LP_L} \to \frac{1}{64}, c_{RP_R} \to \frac{1}{16}, c_{CP} \to \frac{1}{2}, \gamma_N \to \frac{1}{2}, \gamma_{P_{i'}} \to \frac{1}{2}, \beta_N \to \frac{1}{2}, \beta_{P_{i'}} \to \frac{1}{2}$.

When polarization asymmetry $(\alpha_{i'} - \alpha_{-i'})$ is low, any increase in $\alpha_{i'}$ is met with significantly greater competitive framing difference $q^*_{i'N} - q^*_{-i'N}$ value (note the discontinuity in Figure 2a near similar $\alpha_{i'}, \alpha_{-i'}$ values). Thus, extending Proposition 1, Theorem 1 shows that affective polarization impacts partisan framing on neutral websites even when polarization asymmetry is minimal. For instance, after the 2016 US election, BBC News and Reuters (neutral avenues) showed a rapid spike in competitive partisan framing [15]. Moreover, as news has gone digital, neutral and partisan websites have increasingly used partisan framing in response to engagement shifts [58]. Hence, Theorem 1 shows that partisan news source $P_{i'}$ is predictably more (less) responsive in changing its framing quality when the i' consumer ($-i'$ consumer) becomes more polarized.

Non-negative elasticities offer insights into the nature of news framing. Usually, elasticity measures can be positive or negative, signifying an increase or decrease in demand given the changes in price, costs, and nature of goods (Giffen, Veblen, etc.). The non-negativity of elasticity of framing qualities suggests that websites *follow* the engagement; news websites change qualities that reflect changes in engagement levels. This result has potential policy-related implications. First, elasticity of quality is usually characterized as low, given consumer heterogeneity in preferences [17]. Our analysis suggests that framing quality elasticity can be high or low, given polarization as a proxy for preferences. Second, public symbolic goods emphasizing political concerns usually show highly elastic demand [46]. Our analysis of consumers' partisan preferences suggests that these elasticities can vary significantly, from large to minimal, for partisan-framed online news.

Partisan news and consumer engagement have been empirically explored in studies such as [88, 76]. For instance, [76] investigates news sharing on social media from conservative and liberal perspectives, finding that exposure to partisan news significantly influences engagement with news websites, while exposure to opposing partisan news dampens news sharing. However, further exploration is needed to analyze how changes in engagement impact partisan news framing. In line with this, [102] proposes that, along with the useNews dataset, examining the relationship between content's partisan slant and partisan consumer engagement could shed light on the effect of online news on democratic institutions. Theorem 1 offers an analytical foundation.

6 Extensions and Discussions

In this section, we overview several extensions of the inclusive consumption oligopoly model and discuss potential practical implications of our analysis, as summarized in Table 3. These extensions consider factors such as market structure, consumption patterns, and the dominance of affinity versus aversion. Specifically, we consider the *exclusive* consumption oligopoly (Online Appendix Section L.1) and duopoly models (Online Appendix Section L.2), where consumers *choose* to engage or not with a neutral website based on its rival-partisan framing quality, and entirely avoid consumption on rival-partisan websites.[9] The inclusive duopoly scenario (Online Appendix Section L.3) models situations where online news access is either state-controlled [96] or dominated by a majoritarian partisan voice due to limited political competition [8]. Within inclusive consumption, we relax the assumption of affinity dominating aversion in Online Appendix Section L.4. Lastly, we model the scenario where the '*center does not hold*' – a market without pure centrists in Online Appendix L.5.

Our results provide evidence against the 'marketplace of ideas' theory of news markets [44]. The marketplace of ideas theory asserts that ideas should be judged by competition, not censorship [7], and that ideas and ideologies will be judged solely on their worth, popularity, and public approval. However, worth or popularity in an increasingly online world could translate to maximizing engagement through partisan framing. Our model uses this setting to show that competition between news sources using *framing* in an increasingly polarized society could benefit perceived

[9] Please see Online Appendices L.1 and L.2 for further details.

neutral news sources and partisan news sources catering to the dominant partisan consumer group. In the Online Appendix L.4, we further show that neutral news sources lack the incentives to provide bipartisan news framing when aversion dominates affinity. Therefore, it is important to pay attention to engagement to understand and measure competition between online news media. Given partisan-polarization, we suggest gauging competition by examining how framing evolves with engagement using elasticity metrics $\eta_j, j \in \{N, P_L, P_R\}$ in Theorem 1.

Table 3: Industry Implications of our Model Considering Market Structure and Consumption Patterns

	Inclusive Consumption	***Exclusive Consumption***
Oligopoly	• Neutral websites exploit consumer beliefs and converge with partisan websites. • Increasingly polarized consumers engage on neutral (partisan) websites, the greater the leveling (sharpening) tendency. • When aversion dominates, neutral websites turn partisan.	• When MRC is low, neutral websites are better off reporting facts without framing. • When MRC is high, neutral websites are better off engaging partisans equally by setting equal framing qualities.
Duopoly	• Partisan websites engage moderately polarized rival-partisan consumers that show leveling tendency. • Highly polarized partisans with leveling tendencies prefer neutral websites over rival-partisan ones. • When aversion dominates, neutral websites turn partisan.	• Partisan websites are indifferent to engaging the rival partisan consumer. • Neutral websites depend on MRC to decide on framing vs. not framing news.

The market power held by a small number of ad-supported digital platforms, combined with the negotiating power imbalance between news publishers and these platforms, could hamper the monetization of online news content and endanger the survival of the news industry [12]. Further, the drive to maximize engagement could prompt a shift in journalism towards storytelling designed to appeal to partisan tastes [89]. Due to digital platforms' market dominance and news publishers' low bargaining strength, publishers have very few tools to fight these forces. Our analysis suggests exclusive consumption may reduce incentives for objective, bipartisan reporting in low-revenue (low MRC) settings. In contrast, partisan websites may continue to provide biased information to consumers even in exclusive consumption settings or when centrist partisans are absent. Furthermore, neutral websites may not have incentives to present bipartisan-framed news and may also resort to partisan-framed news.

Our model provides intuition regarding the regulatory complexities associated with online news, underscoring the issues inherent in adopting the 'marketplace of ideas' view. Regulating online news is very complex; consumer biases have the potential to influence the neutrality of digital journalism. Moreover, any regulatory intent on these matters can be perceived as a violation of First Amendment rights. The FCC occasionally addresses news *distortions*, but these instances are rare, and the news media can only be penalized for *intentionally* distorting news reports. Our analysis highlights the core issue of measuring news distortions. Perceptions of bias or neutrality can hinder consumer feedback when deciding if a news item is misleading. The FCC does not investigate claims of incidental inaccuracies in news reports or disputes about a news program's integrity, leaving ample space for news media to experiment with framing techniques. Our analysis suggests that such news framing and consumers' cognitive biases may drive consumers to use news sources to support their biases.

Moreover, our analysis in Online Appendix L.5 suggests that without centrist consumers with bipartisan affinities and aversions, partisan websites can increase framing quality to seek '*enraged*' engagement. In some cases, perceiving a source as neutral can allow the consumption of partisan-leaning content that can exacerbate biases (Propositions 3 and 4). The resurgence of arguments for the Fairness Doctrine (FD) [92] also underscores the relevance of our research findings. The 1987-repealed FD required broadcasters to give numerous perspectives on public interest issues, favoring public access to varied voices and opinions over First Amendment safeguards. However, given the evolving nature of the digital media landscape, legal scholars contend that extending the FD to online news providers would require a novel regulatory regime [114].

7 Conclusion and Future Research

In this paper, we present a parsimonious model of the online news market where partisan and neutral news websites compete for polarized consumers with certain cognitive tendencies. We model customer engagement based on news sources' political framing quality and analyze the consumers' biased and neutral beliefs towards news providers. Our equilibrium analysis suggests online news providers strategically exploit consumer perceptions to maximize engagement-driven rewards; neutral news outlets consistently benefit from an imbalance in consumer affective polarization and their perceptions of neutrality. Increased search costs and consumer belief in an outlet's partisan slant can reduce the echo-chamber effect in online news consumption. While recent studies [e.g., 24, 85, 125, 21] have looked at various essential issues regarding polarization and bias, our model collectively captures many of these salient features present in the market for online news, and introduces a way of studying the interaction of publicly held biases (partisan polarization) with privately held beliefs (neutrality/bias perceptions). Table C.1 in the Online Appendix outlines our contributions to the literature, compared to five closely related recent studies.

While our model aims to capture many salient features of digital media and polarization, it nonetheless has limitations. First, our primary focus is how consumer polarization impacts news providers' choice of partisan framing quality, affecting consumer engagement. In this process, we treat consumer polarization as exogenous and do not model the impact of biased news framing on polarization. This is a significant area of investigation in its own right, and future research could focus on understanding how consumer polarization and division evolve due to exposure to biased media. Other research could explore the mutual effects of polarization and media bias using approaches such as agent-based modeling.

Our study also has another limitation: many news providers do not consistently frame their stories right or left. Instead, they typically combine left- and right-leaning news. Fundamentally, not only does the competition fluctuate, but even the definitions of left and right are in constant flux [77]. A news provider's decision-making process thus should include establishing the high-level framing direction of a selection of news offers and framing each information item to engage consumers. Future research could therefore focus on providers' decision-making to simplify the competition model. Specifically, modeling search costs and quality setting as decision variables in a dynamic game could help capture a more nuanced competition strategy for firms employing AI and ML-assisted news reporting. Further, empirical designs and simulation studies in this setting using agent-based modeling may provide new insights.

The increasing use of AI for tasks such as news-gathering, automated writing, website design, and recommendations by online news providers impacts quality framing and consumer search costs [108]. AI and machine learning present several research opportunities with their transformative potential for news gathering, provision, and consumption. For example, the latest release of ChatGPT can write newspaper-style paragraphs [104]. Experimental research on AI-generated or assisted news, exploring consumers' perceptions, framing bias, and cognitive tendencies could reveal important insights about how consumers perceive bias and make decisions in this context. There are also opportunities for lab and digital field experiments to look at variations in framing and signaling, and understand their impact on consumer perceptions and engagement. Some recent experimental studies have already examined such problems (e.g., [78, 73]).

Design Science research can study frameworks and protections that enhance human-AI work and decision allocation to provide news efficiently and ethically. AI can identify news bias by examining word patterns, grammar, and framing [101]. On the other hand, the issue of AI bias extends beyond computational algorithms [112], making it essential to keep humans at the core of AI design [16] in order to address critical societal issues such as ethics and bias. Recent studies have examined the conditions under which decision authority should be allocated to AI or human agents [1, 2], similar to earlier studies on cognitive reapportionment [71]. Empirical observational studies can examine how technology impacts various aspects of digital news. For instance, data from 'useNews' [102] can be used to examine how framing depends on ML-based website design characteristics.

Recent studies underscore the importance of understanding source bias when examining consumer decisions regarding the trustworthiness of a news source [118, 64]. Political polarization and consumer biases influence news providers' reliability, neutrality, and consequently, online news consumption. Our study provides insights into this critical issue of digital media bias and polarization, and our research framework can stimulate further investigations into the workings of digital media and how consumer and societal outcomes could be enhanced.

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Online Appendix

A Online News Media - Neutral and Partisan Bias Ratings

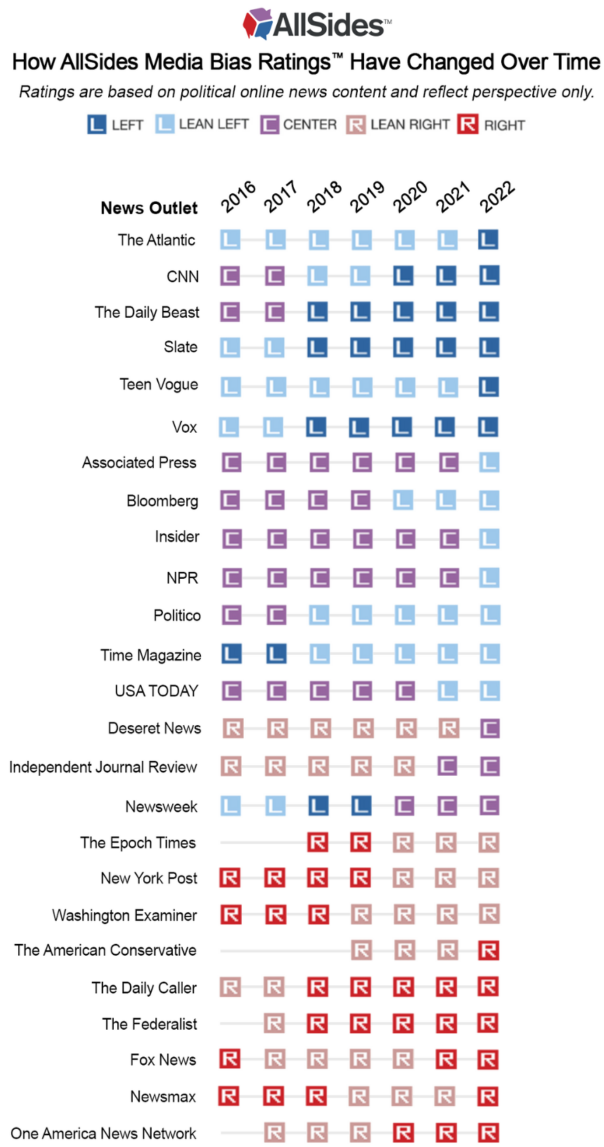

Figure A.1: List of the most popular neutral and partisan news sources and their evolution in terms of neutral/partisan perceptions in the last 5 years (source: https://www.allsides.com/media-bias/ratings.)

B Advanced Technologies and News Organizations

Table B.1: Overview of uses of advanced technologies in News Organizations [11]

Category	*Use*	*Example*
Natural Language Processing	Automated reading	NLP's reading helps newsrooms. NLP analyzes text faster than humans. Trained computer readers increase human readers in Yle and other newsrooms.
	Translation	Knowing the efficiency of machine translation, Le Monde considered publishing a newsletter with 10 to 15 of its more than 100 daily pieces translated into English. Given AI's capacity, the paper quickly developed an English-language edition. Le Monde's webpage now offers French-English. The English edition provides 40 pieces weekdays and 30 weekends. Le Monde's English posts are written and revised in French, then translated by AI and edited.
	Text Analysis	50,000 Atlanta Journal-Constitution subscribers receive an AI-generated email with stories based on their reading history every afternoon. McGhee reports 50,000 more human-curated newsletters. Twipe emails open at 6.5%, whereas human-curated newsletters open at 5%. McGhee admits it is little but has expanded throughout six months of email testing. McGhee prefers automated email reader engagement. They read ten tales a month and check email more often.
	Source and Fact Checking	Yle engineers are studying how AI might detect prejudice or diversity blind spots in stories. This begins tracking sources' demographics, backgrounds, and politics. Sillanpää says Yle News Lab "currently track[s] some attributes manually, but this is understandably time-consuming and does not scale." Next year, Sillanpää wants AI-powered Yle source-tracking. Other indicators show the newsroom who is quoted on what issues, how often, and in what stories.
Generative AI	Stories Written by AI	Narrativa, a natural language generation business that works with publishers, helps Wall Street Journal reporters write stories by piecing together paragraphs on market patterns and financial data. "From that starting point, a reporter can layer on analysis and insight — producing a richer story faster," stated The Journal's research and development editor Alyssa Zeisler in 2021. Our reporters ask "why" while the machine does "what."

Arguably, AI is currently best for paragraphs, not stories, even with training [11, 28], and large language models like GPT-3 and ChatGPT should be used to *assist journalists* rather than write entire articles [11]. These models excel in tasks such as summarization, paraphrasing, and information extraction, acting more like aggregators than original content creators. For instance, Narrativa can construct an AI that writes a paragraph based on public data but cannot report a new story or locate unpublished material [11]. This scenario can be construed under the cognitive reapportionment concept as one where a *combination* of journalists and systems (i.e., algorithms and tools) are being used to boost news organizations' productivity and hence, profitability.

C Related Work Overview

Table C.1: Overview of 5 Closely Related Past Studies and Our Contributions with respect to Them

Paper	*Model Basics & Main Insights*	*Our Contributions*
[91]	***Model***: Monopoly and duopoly models with rational or irrational (readers with beliefs) consumers. ***Main Objective***: Study newspaper competition and its interaction with reader beliefs. ***Insights***: As beliefs diverge, in aggregate readers get accurate information while when beliefs are homogeneous, newspapers do not deliver accurate news.	1. Affective polarization and confirmation vs. falsification biases are irrational. How does a market of consumers with such biases affect news market competition? 2. Engagement—commenting, sharing, blogging, etc.—contextualizes online consumption. Examine how partisan polarization affects engagement heterogeneously. 3. Given the rise of technology that frame news online along partisan lines, study framing quality competitions.
[43]	***Model***: Monopoly and duopoly models with consumers with prior beliefs and media firms publishing *reports* regarding some state of the world that maximizes their reputation. ***Main Objective***: Study reputational concerns in news media competition when serving consumers that have prior beliefs regarding real world events. ***Insights***: Consumers with biases regarding the source's reputation will consider reports from such source as high quality. Competition between news sources will reduce such biases.	1. Include source-content bias (confirmation vs. falsification bias). Analyze news media competition when consumers change involvement levels based on such biases. 2. Analyze competition in online news media where firms compete on framing to promote consumer engagement and reputations are based on partisan stances. 3. Demonstrate how online news engagement may not improve news quality through competition.
[5]	***Model***: Oligopoly model with consumers as voters with partisan leanings, media providing biased news to voters about the candidates. ***Main Objective***: Study how media bias impacts electoral outcomes. ***Insights***: News media may benefit from favoring one candidate over another due to partisan prejudice. Media bias keeps liberal or conservative news listeners from learning about their candidate's flaws. Even if citizens are sensible and consider media bias, they may not recover all the missing knowledge, which could lead to the wrong candidate being elected.	1. Study duopoly competition between partisan and neutral news outlets that reach customers across the political spectrum. 2. Study how partisan polarization interacts with biases and focus on engagement levels instead of electoral outcomes, which may be more critical. 3. Demonstrate that even when a news source wants to look neutral, competition for engagement suggests partisanship. We demonstrate that altering biases affect the payoffs of perceived news sources.
[128]	***Model***: Duopoly model with consumers uniformly distributed between $[0, 1]$ and two news firms located at specific points on the line, repres-enting their bias. ***Main Objective***: Study competition for market coverage for consumers with heterogeneous biases. ***Insights***: Media quality is defined as helping boundedly rational users understand information. If a high-quality media outlet that can remedy bias is too expensive, the model reveals an equilibrium bias. Quality difference impacts the equilibrium bias gap between media outlets.	
[130]	***Model***: Oligopoly model with a single consumer that has sophisticated or naive cognitive processing ability. Using this the consumer can estimate value of a product. Cognitive ability is allowed to be endogenous. ***Main Objective***: Study competition for a consumer whose cognitive ability determine consumption decisions, and thus, firms' payoffs. ***Insights***: Cognitive equilibrium is introduced as a concept. In this equilibrium, consumers can switch between naivety and sophistication based on market exploitation. Monopoly vs. competitive market outcomes. When consumer's cognitive states are exogenous, competition enhances market outcomes, but when they are endogenous, it lowers trade gains.	1. Study duopoly competition between partisan and neutral news sources that engage biased consumers. Crucially, our model considers these biases exogenous, meaning that external influences can improve or worsen them. We model market-level cognition instead of individual consumer cognition. 2. Provide a comparison of cognitive biases about news sources and stories vs. partisan polarization-informed attitudes. 3. Show that online news consumption, where externalities can be off-platform (or off-market), competition can diminish profits from consumption and worsen market outcomes.

D Belief Update Derivation: A Short Note

We begin this derivation by restating some model primitives: priors on content and sources. Specifically, each consumer $i \in \{L, C, R\}$ has a prior regarding the neutrality of N's news item denoted as γ_N and a prior regarding partisan leaning of $P_{i'}$'s news item denoted as $\gamma_{P_{i'}}$. Further, if consumers perceive N's posted news item as neutral, they believe N is neutral without any possibility of being biased; however, if they perceive N's news item as biased, they still believe N is neutral with $\beta_N \in (0, 1)$ probability. Similarly, given consumers perceive $P_{i'}$'s posted news item as i'-aligned, they believe $P_{i'}$ is i'-aligned without any possibility of being neutral; however, if consumers perceive $P_{i'}$'s posted news item as neutral, they still believe $P_{i'}$ is i'-aligned with $\beta_{P_{i'}} \in (0, 1)$ probability.

Stated mathematically, the following are each consumer's priors regarding the source and content.

$$
\begin{aligned}
&P(N's \text{ news item is neutral}) = \gamma_N, \\
&P(P_{i'}'s \text{ news item is i'-leaning}) = \gamma_{P_{i'}}, \\
&P(\text{Source } N \text{ is neutral} | N's \text{ news item is neutral}) = 1, \\
&P(\text{Source } N \text{ is neutral} | N's \text{ news item is biased}) = \beta_N, \\
&P(\text{Source } P_{i'} \text{ is i'-leaning} | P_{i'}'s \text{ news item is i'-leaning}) = 1, \\
&P(\text{Source } P_{i'} \text{ is i'-leaning} | P's \text{ news item is neutral}) = \beta_{P_{i'}}.
\end{aligned}
$$

It is important to note here that these beliefs can be equivalently expressed given consumers perceive N as biased and $P_{i'}$ as neutral. However, we consider the simplest possible mathematical notation that follows our model reasoning.

Now, when consumers $i \in \{L, C, R\}$ observe the news items posted by $N, P_{i'}$ in Stage 2, they update these priors and hold updated beliefs regarding N and $P_{i'}$'s news items neutrality or bias, respectively, given they perceive N as neutral and $P_{i'}$ as i'-leaning (biased). This belief update happens using the conventional Bayes Theorem. We begin by explaining the belief update when considering N and then present the belief update when considering P. For N, the following is the overall belief we are attempting to compute using Bayes' Theorem.

$$P(N's \text{ news item is neutral} | \text{Source } N \text{ is neutral})$$

Observe that this probability is the reverse of the prior $P(\text{Source } N \text{ is neutral}|N's \text{ news item is neutral})$. However, Bayes' Theorem application to compute the probability $P(N's \text{ news item is neutral}|\text{Source } N \text{ is neutral})$ results in the following expression. Basically, we follow the conventional formula of computing $P(A|B) = \frac{P(A)P(B|A)}{P(B)}$ where $P(B)$ in the denominator can be expressed as $P(B) = P(B|A)P(A) + P(B|\bar{A})P(\bar{A})$, where $P(\bar{A}) = 1 - P(A)$. Suppose $A = N's$ news item is neutral, $\bar{A} = N's$ news item is biased and $B =$ Source N is neutral. Then,

$$
\begin{aligned}
P(N's \text{ news item is neutral}|\text{Source } N \text{ is neutral}) = P(A|B) &= \frac{P(A)P(B|A)}{P(B)}, \\
&\Rightarrow \frac{\gamma_N \times 1}{\gamma_N \times 1 + (1-\gamma_N) \times \beta_N}, \\
&\Rightarrow \frac{\gamma_N}{\gamma_N + \beta_N(1-\gamma_N)},
\end{aligned}
$$

which is the updated belief regarding N's news item being neutral (σ_N) as mentioned in the Section 3.2. Now, consider the problem of $P_{i'}$. For $P_{i'}$, the following is the overall belief we are attempting to compute using Bayes' Theorem.

$$P(P_{i'}'s \text{ news item is i'-leaning}|\text{Source } P_{i'} \text{ is i'-leaning})$$

Observe that this probability is the reverse of the prior $P(\text{Source } P_{i'} \text{ is i'-leaning}|P_{i'}'s \text{ news item is i'-leaning})$. Using the same procedure as above for N and noting that now

$$
\begin{aligned}
A &= P_{i'}'s \text{ news item is i'-leaning}, \\
\bar{A} &= P_{i'}'s \text{ news item is neutral}, \\
B &= \text{Source } P_{i'} \text{ is i'-leaning},
\end{aligned}
$$

we have that:

$$
\begin{aligned}
P(P_{i'}'s \text{ news item is i'-leaning}|\text{Source } P_{i'} \text{ is i'-leaning}) = P(A|B) &= \frac{P(A)P(B|A)}{P(B)}, \\
&\Rightarrow \frac{\gamma_{P_{i'}} \times 1}{\gamma_{P_{i'}} \times 1 + (1-\gamma_{P_{i'}}) \times \beta_{P_{i'}}},
\end{aligned}
$$

$$\Rightarrow \frac{\gamma_{P_{i'}}}{\gamma_{P_{i'}} + \beta_{P_{i'}}(1-\gamma_{P_{i'}})},$$

which is exactly the belief update ($\sigma_{P_{i'}}$) mentioned in Section 3.2. Of course, we do simplify these computations considerably when considering $P(\bar{A})$ in either case. For instance, it is possible that in the case of N, $\bar{A}$ could mean 'N is left-leaning or 'N is right-leaning specifically; in the case of P_L, $\bar{A}$ could mean 'P_L is right-leaning specifically. However, our model intends to capture competitive behavior between a perceived neutral and a perceived biased website, and so we simplify our belief considerations to capture an important facet of consumption online – the source vs. content bias.

E Proofs of Lemma 1

Proof. In order to derive the equilibrium qualities and engagements, we use the traditional backward induction and begin in Stage 2. First, note that each consumer i is solving the optimization problem given by equation (3) when consuming from N and $P_{i'}$ with finite attention $\varphi_{iN} \in (0,1)$ dedicated to N, and the rest $(1-\varphi_{iN})$ allocated between P_L and P_R. Since the consumption utilities are concave in a_{iN} and a_{iP}, the first-order conditions give the optimum engagement by the concavity property.

That is, the sub-game perfect engagement levels are ($i' \in \{L, R\}$):

$$a_{LN} = \frac{1}{2}\left(v + \frac{\beta_N(1-\gamma_N)((\alpha_L+1)q_{LN} - \alpha_L q_{RN})}{\beta_N(1-\gamma_N)+\gamma_N}\right), \tag{5}$$

$$a_{RN} = \frac{1}{2}\left(v - \frac{\beta_N(1-\gamma_N)(\alpha_R q_{LN} - (\alpha_R+1)q_{RN})}{\beta_N(1-\gamma_N)+\gamma_N}\right) \tag{6}$$

$$a_{i'P_{i'}} = \frac{v + \frac{\alpha_{i'}\gamma_{P_{i'}} q_{i'P_{i'}}}{\beta_{P_{i'}}(1-\gamma_{P_{i'}})+\gamma_{P_{i'}}}}{2c_{i'P_{i'}}}, \tag{7}$$

$$a_{i'P_{-i'}} = \frac{v - \frac{\alpha_{i'}\gamma_{P_{-i'}} q_{P_{-i'}}}{\beta_{P_{-i'}}(1-\gamma_{P_{-i'}})+\gamma_{P_{-i'}}}}{2}, \tag{8}$$

$$a_{CN} = \frac{1}{2}\left(v + \left(1 - \frac{\gamma_N}{\beta_N(1-\gamma_N)+\gamma_N}\right)(q_{LN}+q_{RN})\right), \tag{9}$$

$$a_{CP_{i'}} = \frac{v + \frac{\gamma_{P_{i'}} q_{P_{i'}}}{\beta_{P_{i'}}(1-\gamma_{P_{i'}})+\gamma_{P_{i'}}}}{2c_{CP}}. \tag{10}$$

Given these engagement levels, in Stage 1, N and $P_{i'}$ simultaneously set framing qualities $\{q_{LN}, q_{RN}\}$ and $q_{P_{i'}}$, respectively, to maximize payoffs from engagement. Again, we note that the concave nature of $\pi_N, \pi_{P_{i'}}$ implies that the first-order conditions will be the solution to maximizing payoffs. So, substituting equations (5)-(10) into equations (1) and (2), differentiating π_N with respect to q_{LN}, q_{RN} and $\pi_{P_{i'}}$ with respect to $q_{P_{i'}}$, we get the following first-order conditions:

$$\frac{\partial \pi_N}{\partial q_{LN}} \equiv \frac{\beta_N(\gamma_N - 1)r_N(\alpha_L - \alpha_R + 2)}{2\beta_N(\gamma_N - 1) - 2\gamma_N} - 2k_N q_{LN} = 0, \tag{11}$$

$$\frac{\partial \pi_N}{\partial q_{RN}} \equiv \frac{\beta_N(\gamma_N - 1)r_N(\alpha_L - \alpha_R - 2)}{2(\beta_N(-\gamma_N) + \beta_N + \gamma_N)} - 2k_N q_{RN} = 0, \tag{12}$$

$$\frac{\partial \pi_{P_{i'}}}{\partial q_{P_{i'}}} \equiv -\frac{\gamma_{P_{i'}} r_{P_{i'}}(c_{i'P_{i'}} - c_{CP}\alpha_{i'} + c_{CP}c_{i'P_{i'}}\alpha_{-i'})}{2c_{CP}c_{i'P_{i'}}(\beta_{P_{i'}}(1-\gamma_{P_{i'}}) + \gamma_{P_{i'}})} - 2k_{P_{i'}} q_{P_{i'}} = 0 \tag{13}$$

Solving these equations simultaneously for $q_{LN}, q_{RN}, q_{P_{i'}}$ gives the optimal framing qualities as follows:

$$q^*_{LN} = \frac{r_N}{k_N}\left(\frac{(1-\sigma_N)(2+\alpha_L-\alpha_R)}{4}\right) \tag{14}$$

$$q^*_{RN} = \frac{r_N}{k_N}\left(\frac{(1-\sigma_N)(2+\alpha_R-\alpha_L)}{4}\right) \tag{15}$$

$$q^*_{P_{i'}} = \frac{r_{P_{i'}}}{k_{P_{i'}}}\left(\frac{\sigma_{P_{i'}}(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'}+1))}{4c_{CP}c_{i'P_{i'}}}\right). \tag{16}$$

Now, since we are considering interior equilibrium with necessarily positive framing qualities, it follows that our assumptions that consider this equilibrium, which are:

$$A1 : c_{i'P_{i'}} \in \left(0, \frac{c_{CP}\alpha_{i'}}{1 + c_{CP}\alpha_{-i'}}\right),$$
$$A2 : \frac{r_{P_{i'}}}{k_{P_{i'}}} \in \left(0, \frac{4c_{CP}c_{i'P_{i'}}}{\sigma_{P_{i'}}(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'}+1))}\right),$$

and the parameter assumptions which are:

$$A3 : \gamma_j, \beta_j \in (0,1),$$

$$A4 : \alpha_{i'} \in (0,1),$$

$\forall\, i \in \{L, C, R\}, j \in \{N, P_L, P_R\}$ help ensure that $q^*_{P_{i'}} > 0$ and finally $q^*_{LN}, q^*_{RN} > 0$.

Now, having obtained the Stage 1 equilibrium framing qualities, in order to derive the Stage 2 (sub-game perfect) engagement levels, we substitute these framing qualities back into equations (5)-(10) and obtain the following ($i \neq -i'$, $\forall\, i', -i'\{L, R\}$):

$$a_{i'N} = \frac{1}{2}\left(v + \frac{r_N}{k_N}\left(\frac{\sigma_N^2\,(2 + (\alpha_{i'} - \alpha_{-i'})(1 + 2\alpha_{i'}))}{4}\right)\right), \tag{17}$$

$$a_{i'P_{i'}} = \frac{1}{2c_{i'P_{i'}}}\left(v + \frac{r_{P_{i'}}}{k_{P_{i'}}}\left(\frac{\alpha_{i'}\sigma^2_{P_{i'}}(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'}+1))}{4c_{CP}c_{i'P_{i'}}}\right)\right), \tag{18}$$

$$a_{i'P_{-i'}} = \frac{1}{2}\left(v - \frac{r_{P_{-i'}}}{k_{P_{-i'}}}\left(\frac{\alpha_{i'}\sigma^2_{P_{-i'}}(c_{CP}\alpha_{-i'} - c_{P_{-i'}}(c_{CP}\alpha_{i'}+1))}{4c_{CP}c_{P_{-i'}}}\right)\right), \tag{19}$$

$$a^*_{CN} = \frac{1}{2}\left(v + \frac{r_N\sigma^2_N}{k_N}\right), \tag{20}$$

$$a^*_{CP_{i'}} = \frac{1}{2c_{CP}}\left(v - \frac{r_{P_{i'}}}{k_{P_{i'}}}\left(\frac{\sigma^2_{P_{i'}}(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'}+1))}{4c_{CP}c_{i'P_{i'}}}\right)\right). \tag{21}$$

where under assumptions A1-A2, all the engagement levels derived are strictly positive.

In order to prove the existence of equilibrium with these derived values, we consider the following numeric values of framing qualities and engagements, associated payoffs for N, P_L, P_R:

Parameter Values – note that these values satisfy A1 - A4:

$$\{v \to 2, k_N \to 1, k_{P_{i'}} \to 1, r_{P_{i'}} \to 1, c_{LP_L} \to \tfrac{1}{64}, c_{RP_R} \to \tfrac{1}{16}, c_{CP} \to \tfrac{1}{2}, \gamma_N \to \tfrac{1}{2}, \gamma_{P_{i'}} \to \tfrac{1}{2}, \beta_N \to \tfrac{1}{2}, \beta_{P_{i'}} \to \tfrac{1}{2}, \alpha_L \to \tfrac{1}{16}, \alpha_R \to \tfrac{1}{4}, \varphi_{ij} \to \tfrac{1}{3} \forall i \in \{L, C, R\}\}$$

Equilibrium Values:

$$\begin{aligned}
&q^*_{LN} = \frac{29}{192}, q^*_{RN} = \frac{35}{192}, q^*_{P_L} = \frac{7}{24}, q^*_{P_R} = \frac{31}{96}\\
&a^*_{LN} = \frac{9445}{9216}, a^*_{RN} = \frac{2377}{2304}, a^*_{CN} = \frac{19}{18}\\
&a^*_{LP_L} = \frac{1159}{18}, a^*_{LP_R} = \frac{4577}{4608}, a^*_{RP_L} = \frac{281}{288}, a^*_{RP_R} = \frac{1183}{72},\\
&a^*_{CP_L} = \frac{65}{36}, a^*_{CP_R} = \frac{257}{144},\\
&\pi^*_N = \frac{56329}{18432}, \pi^*_{P_L} = \frac{38641}{576}, \pi^*_{P_R} = \frac{176065}{9216},\\
&u^*_L = \frac{1891694239}{84934656}, u^*_R = \frac{33423643}{5308416}, u^*_C = \frac{179857}{124416}.
\end{aligned}$$

Hence, we have shown numerically and analytically that our derived interior equilibrium holds under the conditions of A1-A2. □

F Proof of Lemma 2

Proof. The proof for Lemma 2 will proceed using proof by deduction. Essentially, we will provide the equilibrium values of qualities, evaluate the competitive framing expressions, and under the assumptions of equilibrium existence A1 and A2, show how different regions of MRC imply different competitive framing implications.

Competitive Partisan Framing between N and $P_{i'}, P_{-i'}$: From Lemma 1, it follows that the expression when comparing qualities between N and $P_{i'}$ is as follows:

$$\begin{aligned}\Delta_{P_{i'},N} &= q^*_{P_{i'}} - q^*_{i'N},\\ &\Rightarrow \frac{1}{4}\left(\frac{\sigma_{P_{i'}} r_{P_{i'}}(c_{CP}c_{i'P_{i'}}\alpha_{-i'} - c_{CP}\alpha_{i'} + c_{i'P_{i'}})}{c_{CP}c_{i'P_{i'}}k_{P_{i'}}} + \frac{\sigma_N r_N(\alpha_{i'} - \alpha_{-i'} + 2)}{k_N}\right).\end{aligned}$$

Now, this expression can be positive or negative based on values of the parameters under assumptions A3, and A4. Accordingly, analyzing the range of values for which $\Delta_{P_{i'},N} < 0$ gives the following:

$$\begin{aligned}\Delta_{P_{i'},N} < 0 &\Rightarrow \frac{1}{4}\left(\frac{\sigma_{P_{i'}} r_{P_{i'}}(c_{CP}c_{i'P_{i'}}\alpha_{-i'} - c_{CP}\alpha_{i'} + c_{i'P_{i'}})}{c_{CP}c_{i'P_{i'}}k_{P_{i'}}} + \frac{(1-\sigma_N) r_N(\alpha_{i'} - \alpha_{-i'} + 2)}{k_N}\right) < 0\\ &\Rightarrow \frac{(1-\sigma_N) r_N(\alpha_{i'} - \alpha_{-i'} + 2)}{k_N} < \frac{\sigma_{P_{i'}} r_{P_{i'}}(c_{CP}c_{i'P_{i'}}\alpha_{-i'} - c_{CP}\alpha_{i'} + c_{i'P_{i'}})}{c_{CP}c_{i'P_{i'}}k_{P_{i'}}}\\ &\Rightarrow \frac{r_N}{k_N} < \frac{\sigma_{P_{i'}} r_{P_{i'}}(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'} + 1))}{(1-\sigma_N)(\alpha_{i'} - \alpha_{-i'} + 2)c_{CP}c_{i'P_{i'}}k_{P_{i'}}}\\ &\Rightarrow \frac{\frac{r_N}{k_N}}{\frac{r_{P_{i'}}}{k_{P_{i'}}}} < \frac{\sigma_{P_{i'}}(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'} + 1))}{(1-\sigma_N)(2 + \alpha_{i'} - \alpha_{-i'})c_{CP}c_{i'P_{i'}}}\\ &\Rightarrow \frac{\frac{r_N}{k_N}}{\frac{r_{P_{i'}}}{k_{P_{i'}}}} < \frac{\sigma_{P_{i'}}}{(1-\sigma_N)}\left(\frac{(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'} + 1))}{(2 + \alpha_{i'} - \alpha_{-i'})c_{CP}c_{i'P_{i'}}}\right)\end{aligned}$$

which is as per the expression in Lemma 2. Similarly, analyzing the expression for $\Delta_{P_{-i'},N} > 0$ using Lemma 1 derived qualities, we have:

$$\begin{aligned}\Delta_{P_{-i'},N} > 0 &\Rightarrow \frac{1}{4}\left(\frac{\sigma_{P_{i'}} r_{P_{-i'}}(c_{CP}c_{-i'P_{-i'}}\alpha_{i'} - c_{CP}\alpha_{-i'} + c_{-i'P_{-i'}})}{c_{CP}c_{-i'P_{-i'}}k_{P_{-i'}}} + \frac{(1-\sigma_N) r_N(\alpha_{-i'} - \alpha_{i'} + 2)}{k_N}\right) > 0\\ &\Rightarrow \frac{r_N}{k_N} > \frac{\sigma_{P_{i'}} r_{P_{-i'}}(c_{CP}\alpha_{-i'} - c_{-i'P_{-i'}}(c_{CP}\alpha_{i'} + 1))}{(1-\sigma_N)(\alpha_{-i'} - \alpha_{i'} + 2)c_{CP}c_{-i'P_{-i'}}k_{P_{-i'}}}\\ &\Rightarrow \frac{\frac{r_N}{k_N}}{\frac{r_{P_{-i'}}}{k_{P_{-i'}}}} > \frac{\sigma_{P_{-i'}}}{(1-\sigma_N)}\left(\frac{(c_{CP}\alpha_{-i'} - c_{-i'P_{-i'}}(c_{CP}\alpha_{i'} + 1))}{(2 + \alpha_{-i'} - \alpha_{i'})c_{CP}c_{-i'P_{-i'}}}\right).\end{aligned}$$

Hence, we have shown that competitive partisan framing between N and $P_{i'}, P_{-i'}$ follows the behavior as described in Lemma 2.

Competitive Partisan Framing between $P_{i'}, P_{-i'}$: From Lemma 2, it follows that the expression when comparing qualities between $P_{i'}$ and $P_{-i'}$ is as follows:

$$\Delta_{P_{i'},P_{-i'}} = \frac{1}{4c_{CP}}\left(\frac{\sigma_{P_{-i'}} r_{P_{-i'}}(c_{CP}c_{-i'P_{-i'}}\alpha_{i'} - c_{CP}\alpha_{-i'} + c_{-i'P_{-i'}})}{c_{-i'P_{-i'}} k_{P_{-i'}}} - \frac{\sigma_{P_{i'}} r_{P_{i'}}(c_{CP}c_{i'P_{i'}}\alpha_{-i'} - c_{CP}\alpha_{i'} + c_{i'P_{i'}})}{c_{i'P_{i'}} k_{P_{i'}}}\right)$$

Now, analyzing this expression to see where it is positive gives the following:

$$\begin{aligned}
\Delta_{P_{i'},P_{-i'}} > 0 &\Rightarrow \frac{\sigma_{P_{-i'}} r_{P_{-i'}}(c_{CP}\alpha_{-i'} - c_{-i'P_{-i'}}(c_{CP}\alpha_{i'}+1))}{c_{-i'P_{-i'}} k_{P_{-i'}}} < \frac{\sigma_{P_{i'}} r_{P_{i'}}(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'}+1))}{c_{i'P_{i'}} k_{P_{i'}}} \\
&\Rightarrow \frac{\frac{r_{P_{i'}}}{k_{P_{i'}}}}{\frac{r_{P_{-i'}}}{k_{P_{-i'}}}} > \frac{\sigma_{P_{-i'}}}{\sigma_{P_{i'}}}\left(\frac{(c_{CP}\alpha_{-i'} - c_{-i'P_{-i'}}(c_{CP}\alpha_{i'}+1))}{(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'}+1))}\right)
\end{aligned}$$

which is as per the expression in Lemma 2. □

G Proof of Proposition 1

Proof. We begin the proof by noting that the derivatives of q^*_{LN}, q^*_{RN} with respect to polarization degrees $\alpha_{i'}, i' \in \{L, R\}$ are as follows:

$$\frac{\partial q^*_{i'N}}{\partial \alpha_{i'}} = \frac{(1-\sigma_N) r_N}{4k_N} > 0, \tag{22}$$
$$\frac{\partial q^*_{-i'N}}{\partial \alpha_{i'}} = -\frac{(1-\sigma_N) r_N}{4k_N} < 0, \tag{23}$$

under assumptions A1-A4. Next, we note that the derivatives of $q^*_{P_{i'}}$ with respect to $\alpha_i, i' \in \{L, R\}$ are as follows:

$$\frac{\partial q^*_{P_{i'}}}{\partial \alpha_{i'}} = \frac{\sigma_{P_{i'}} r_{P_{i'}}}{4c_{i'P_{i'}} k_{P_{i'}}} > 0, \tag{24}$$
$$\frac{\partial q^*_{P_{-i'}}}{\partial \alpha_{i'}} = -\frac{\sigma_{P_{-i'}} r_{P_{-i'}}}{4k_{P_{-i'}}} < 0, \tag{25}$$

again, under assumptions A1-A4. Using these expressions, we can now analyze the change in competitive partisan framing when polarization changes. In order to structure the proof, we enumerate the expressions concerning competitive partisan framing we analyze:

- $\frac{\partial \Delta_{P_{i'},N}}{\partial \alpha_{i'}} = \frac{\partial q^*_{P_{i'}}}{\partial \alpha_{i'}} - \frac{\partial q^*_{i'N}}{\partial \alpha_{i'}}$.
- $\frac{\partial \Delta_{P_{-i'},N}}{\partial \alpha_{i'}} = \frac{\partial q^*_{P_{-i'}}}{\partial \alpha_{i'}} - \frac{\partial q^*_{-i'N}}{\partial \alpha_{i'}}$.

- $\frac{\partial \Delta_{P_{i'},P_{-i'}}}{\partial c_{CP}} = \frac{\partial q^*_{P_{i'}}}{\partial c_{CP}} - \frac{\partial q^*_{P_{-i'}}}{\partial c_{CP}}$.

From the already derived expressions for α_i change (equations 23 and 24), we analyze first the competitive partisan framing comparative statics between N and $P_{i'}, P_{-i'}$:

$$\frac{\partial \Delta_{P_{i'},N}}{\partial \alpha_{i'}} = \frac{\sigma_{P_{i'}} r_{P_{i'}}}{4c_{i'P_{i'}} k_{P_{i'}}} - \left(\frac{(1-\sigma_N) r_N}{4k_N}\right)$$
$$\frac{\partial \Delta_{P_{-i'},N}}{\partial \alpha_{i'}} = -\frac{\sigma_{P_{-i'}} r_{P_{-i'}}}{4k_{P_{i'}}} + \left(\frac{(1-\sigma_N) r_N}{4k_N}\right)$$

Hence, $\frac{\partial \Delta_{P_{i'},N}}{\partial \alpha_{i'}} < 0$ when $\frac{\frac{r_N}{k_N}}{\frac{r_{P_{i'}}}{k_{P_{i'}}}} > \frac{\sigma_{P_{i'}}}{4c_{i'P_{i'}}(1-\sigma_N)}$ while $\frac{\partial \Delta_{P_{-i'},N}}{\partial \alpha_{i'}} > 0$ when $\frac{\frac{r_N}{k_N}}{\frac{r_{P_{-i'}}}{k_{P_{-i'}}}} > \frac{\sigma_{P_{-i'}}}{4(1-\sigma_N)}$.

We now consider the competitive partisan framing between $P_{i'}, P_{-i'}$. In this case, the following is the expression to analyze:

$$\frac{\partial \Delta_{P_{i'},P_{-i'}}}{\partial c_{CP}} = \frac{1}{4c_{CP}^2}\left(\frac{\sigma_{P_{i'}} r_{P_{i'}}}{k_{P_{i'}}} - \frac{\sigma_{P_{-i'}} r_{P_{-i'}}}{k_{P_{-i'}}}\right).$$

Analyzing this expression, it follows that $\frac{\partial \Delta_{P_{i'},P_{-i'}}}{\partial c_{CP}} > 0$ when $\frac{\frac{r_{P_{i'}}}{k_{P_{i'}}}}{\frac{r_{P_{-i'}}}{k_{P_{-i'}}}} > \frac{\sigma_{P_{-i'}}}{\sigma_{P_{i'}}}$. Hence, we have proved the main aspects of Proposition 1. □

H Proof of Proposition 2

Proof. We begin the proof by noting that the equilibrium values of payoffs for the three websites are as follows:

$$\pi^*_N = \frac{3}{2}\left(\frac{(1-\sigma_N)^2 r_N^2\left((\alpha_{i'}-\alpha_{-i'})^2+4\right)}{12k_N} + v\right),$$
$$\pi^*_{P_{i'}} = \frac{r_{P_{i'}}\left(\frac{\sigma^2_{P_{i'}} r_{P_{i'}}(c_{CP}c_{i'P_{i'}}\alpha_{-i'} - c_{CP}\alpha_{i'} + c_{i'P_{i'}})^2}{k_{P_{i'}}} + 8c_{CP}c_{i'P_{i'}}v(c_{CP}c_{i'P_{i'}} + c_{CP} + c_{i'P_{i'}})\right)}{16c_{CP}^2 c_{i'P_{i'}}^2}.$$

The derivative of N's payoff π^*_N with respect to polarization degrees α_L and α_R are as follows:

$$\frac{\partial \pi^*_N}{\partial \alpha_{i'}} = \frac{(1-\sigma_N)^2 r_N^2(\alpha_{i'}-\alpha_{-i'})}{4k_N}, \quad (26)$$
$$\frac{\partial \pi^*_N}{\partial \alpha_{-i'}} = -\frac{(1-\sigma_N)^2 r_N^2(\alpha_{i'}-\alpha_{-i'})}{4k_N}. \quad (27)$$

In essence, it follows that $\frac{\partial \pi^*_N}{\partial \alpha_{i'}} = -\frac{\partial \pi^*_N}{\partial \alpha_{-i'}}$. Now, observe that in the expressions for $\frac{\partial \pi^*_N}{\partial \alpha'}, \frac{\partial \pi^*_N}{\partial \alpha_{-i'}}$, the term $\alpha_{i'} - \alpha_{-i'}$ is not squared, implying that depending on whether $\alpha_{i'} > \alpha_{-i'}$ or otherwise, sign of the derivative can change. Accordingly, it follows that when $\alpha_{i'} \leq \alpha_{-i'}$ and $\alpha_{i'}$ increases, we obtain $\frac{\partial \pi^*_N}{\partial \alpha_{i'}} \leq 0$ while $\frac{\partial \pi^*_N}{\partial \alpha_{-i'}} \geq 0$.

Now consider the derivative of $P_{i'}$'s payoff ($\pi^*_{P_{i'}}$) with respect to the polarization degrees $\alpha_{i'}$ and $\alpha_{-i'}$ are as follows:

$$\frac{\partial \pi^*_{P_{i'}}}{\partial \alpha_{i'}} = \frac{\sigma^2_{P_{i'}} r^2_{P_{i'}} (c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'} + 1))}{8 c_{CP} c^2_{i'P_{i'}} k_{P_{i'}}} \tag{28}$$

$$\frac{\partial \pi^*_{P_{i'}}}{\partial \alpha_{-i'}} = -\frac{\sigma^2_{P_{i'}} r^2_{P_{i'}} (c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'} + 1))}{8 c_{CP} c_{i'P_{i'}} k_{P_{i'}}}. \tag{29}$$

In essence, it follows that $\frac{\partial \pi^*_{P_{i'}}}{\partial \alpha_{-i'}} = -\frac{1}{c_{i'P_{i'}}} \frac{\partial \pi^*_{P_{i'}}}{\partial \alpha_{i'}}$. Under assumptions A1, A2, the expressions for $\frac{\partial \pi^*_{P_{i'}}}{\partial \alpha_{i'}} > 0$ implying that $\frac{\partial \pi^*_{P_{i'}}}{\partial \alpha_{-i'}} < 0$. □

I Proof of Proposition 3

Proof. We begin the proof by noting the expressions for the derivative of engagement level $a_{i'N}$ with respect to $\alpha_{i'}$. Specifically, the following are the expressions of the derivatives mentioned as part of Proposition 3:

$$\frac{\partial a^*_{i'N}}{\partial \alpha_{i'}} = \frac{(1-\sigma_N)^2 r_N (4\alpha_{i'} - 2\alpha_{-i'} + 1)}{8k_N} \tag{30}$$

$$\frac{\partial^2 a_{i'N}}{\partial \alpha_{i'} \partial \beta_N} = \frac{(1-\sigma_N)^2 \beta_N \gamma_N r_N (4\alpha_{i'} - 2\alpha_{-i'} + 1)}{4k_N(\beta_N(1-\gamma_N) + \gamma_N)} \tag{31}$$

$$\frac{\partial^2 a_{i'N}}{\partial \alpha_{i'} \partial \gamma_N} = -\frac{(1-\sigma_N)\beta_N r_N (4\alpha_{i'} - 2\alpha_{-i'} + 1)}{4k_N(\beta_N(1-\gamma_N) + \gamma_N)^2} \tag{32}$$

Analyzing these expressions separately establishes the ranges as given in Proposition 3. First, observe that both in the numerator and denominator, the only expression that can be positive or negative $(4\alpha_{i'} - 2\alpha_{-i'} + 1)$. Therefore the sign of the derivative depends on the sign of this expression. In establishing the ranges from this expression, note that since the derivatives consider an increasing $\alpha_{i'}$, we bound the region of $\alpha_{i'}$ for a given $\alpha_{-i'}$. In other words, when considering the following inequality, we focus on establishing a region of $\alpha_{i'}$ for a given value of $\alpha_{-i'}$, as follows.

$$(4\alpha_{i'} - 2\alpha_{-i'} + 1) > 0$$

$$\Rightarrow 4\alpha_{i'} > 2\alpha_{-i'} - 1$$

$$\Rightarrow \alpha_{i'} > \frac{\alpha_{-i'}}{2} - \frac{1}{4}.$$

Observe that since we assume $\alpha_{i'}, \alpha_{-i'} \in (0, 1)$, it must be true that $0 < \frac{\alpha_{-i'}}{2} - \frac{1}{4} \leq 1 \Rightarrow \frac{1}{4} < \frac{\alpha_{-i'}}{2} \leq \frac{5}{4} \equiv \frac{1}{2} < \alpha_{-i'} \leq \frac{5}{2}$ which simplifies to $\frac{1}{2} < \alpha_{-i'} \leq 1$ since $\alpha_{-i'} \in (0, 1)$. Hence, given $\frac{1}{2} < \alpha_{-i'} \leq 1$, when $\alpha_{i'} > \frac{\alpha_{-i'}}{2} - \frac{1}{4}$, then as shown, $\frac{\partial a^*_{i'N}}{\partial \alpha_{i'}} > 0$, $\frac{\partial^2 a_{i'N}}{\partial \alpha_{i'} \partial \beta_N} > 0$ and $\frac{\partial^2 a_{i'N}}{\partial \alpha_{i'} \partial \gamma_N} < 0$. That is, increasing polarization affects engagement in a way that sharpening tendency has a positive effect on the rate of increase while leveling tendency has the inverse effect. $\square$

J Proof of Proposition 4

Proof. We begin the proof by noting the following expressions for $\frac{\partial a^*_{i'P_{-i'}}}{\partial \alpha_{i'}}, \frac{\partial a^*_{i'P_{-i'}}}{\partial \alpha_{i'} \partial \gamma_{P_{-i'}}}, \frac{\partial a^*_{i'P_{-i'}}}{\partial \alpha_{i'} \partial \beta_{P_{-i'}}}$, as follows:

$$\frac{\partial a^*_{i'P_{-i'}}}{\partial \alpha_{i'}} = \frac{\sigma^2_{P_{-i'}} r_{P_{-i'}} (2c_{CP} c_{-i'P_{-i'}} \alpha_{i'} - c_{CP} \alpha_{-i'} + c_{-i'P_{-i'}})}{8 c_{CP} c_{-i'P_{-i'}} k_{P_{-i'}}}$$
$$\frac{\partial a^*_{i'P_{-i'}}}{\partial \alpha_{i'} \partial \gamma_{P_{-i'}}} = \frac{\sigma_{P_{-i'}} \beta_{P_{-i'}} r_{P_{-i'}} (2c_{CP} c_{-i'P_{-i'}} \alpha_{i'} - c_{CP} \alpha_{-i'} + c_{-i'P_{-i'}})}{4 c_{CP} c_{-i'P_{-i'}} k_{P_{-i'}} (\beta_{P_{-i'}}(1 - \gamma_{P_{-i'}}) + \gamma_{P_{-i'}})^2}$$
$$\frac{\partial a^*_{i'P_{-i'}}}{\partial \alpha_{i'} \partial \beta_{P_{-i'}}} = -\frac{\sigma^2_{P_{-i'}} (1 - \gamma_{P_{-i'}}) r_{P_{-i'}} (2c_{CP} c_{-i'P_{-i'}} \alpha_{i'} - c_{CP} \alpha_{-i'} + c_{-i'P_{-i'}})}{4 c_{CP} c_{-i'P_{-i'}} k_{P_{-i'}} (\beta_{P_{-i'}}(1 - \gamma_{P_{-i'}}) + \gamma_{P_{-i'}})}$$

Observe that in the derivatives for engagement levels on $P_{-i'}$, under assumptions A1-A4, the only expression that determines the sign of the derivatives is $(2c_{CP} c_{-i'P_{-i'}} \alpha_{i'} - c_{CP} \alpha_{-i'} + c_{-i'P_{-i'}})$.

More concretely, analyzing the expression as follows:

$$(2c_{CP} c_{-i'P_{-i'}} \alpha_{i'} - c_{CP} \alpha_{-i'} + c_{-i'P_{-i'}}) > 0$$
$$\Rightarrow c_{-i'P_{-i'}} (2c_{CP} \alpha_{i'} + 1) > c_{CP} \alpha_{-i'}$$
$$\Rightarrow c_{-i'P_{-i'}} > \frac{c_{CP} \alpha_{-i'}}{(2c_{CP} \alpha_{i'} + 1)}$$

From A1 (refer Proof for Lemma 1 in Section E), we know that $c_{i'P_{i'}} \in \left(0, \frac{c_{CP}\alpha_{i'}}{1 + c_{CP}\alpha_{-i'}}\right)$. It follows that the derived range for $c_{-i'P_{-i'}}$ is simply $c_{-i'P_{-i'}} \in \left(\frac{c_{CP}\alpha_{-i'}}{(2c_{CP}\alpha_{i'}+1)}, \frac{c_{CP}\alpha_{-i'}}{(c_{CP}\alpha_{i'}+1)}\right)$ within which $\frac{\partial a^*_{i'P_{-i'}}}{\partial \alpha_{P_{i'}}} > 0$, $\frac{\partial a^*_{i'P_{-i'}}}{\partial \alpha_{i'} \partial \gamma_{P_{-i'}}} > 0$ and $\frac{\partial a^*_{i'P_{-i'}}}{\partial \alpha_{i'} \partial \beta_{P_{-i'}}} < 0$. That is, increasing polarization affects engagement in a way that the leveling tendency has a positive effect on the rate of increase while the sharpening tendency has the inverse effect. $\square$

K Proof of Theorem 1

Proof. We begin the proof by explaining the overall proof strategy. We use Implicit Function Theorem, at the equilibrium quantities of quality and engagement levels, to derive the elasticity measure. Specifically, we use the FOCs as derived in Section E to construct a set of linear simultaneous equations where the unknowns are the derivatives $\frac{\partial q_{i'N}}{\partial a_{i'N}}, \frac{\partial q_{P_{i'}}}{\partial a_{i'P_{i'}}}, \frac{\partial q_{P_{i'}}}{\partial a_{-i'P_{i'}}}$. These form the core of the quantities required to compute the elasticities.

Elasticity on N: Consider the FOC's of second stage, with the equilibrium quantities of engagement and framing qualities ($i' \in \{L, R\}$):

$$a^*_{i'N} = \frac{1}{2}\left(v + (1-\sigma_N)((1+\alpha_{i'})q^*_{i'N} - \alpha_{i'}q^*_{-i'N})\right),$$
$$a^*_{CN} = \frac{1}{2}\left(v + (1-\sigma_N)(q^*_{i'N} + q^*_{-i'N})\right)$$

In order to derive the derivatives of framing qualities w.r.t engagement levels, we consider the qualities to be functions of engagement levels from L, C, R such that $q^*_{i'N}(a^*_{i'N}, a^*_{CN})$. Now, to generate the simultaneous equations that can help compute the derivatives, we differentiate the above FOCs w.r.t a parameter that is common to both qualities and engagement levels. In this case, that parameter is the polarization degree $\alpha_{i'}$. Therefore differentiating the above FOCs w.r.t $\alpha_{i'}, \alpha_{-i'}$ we have the following equations.

$$\begin{aligned}\frac{\partial a^*_{i'N}}{\partial \alpha_{i'}} = \frac{1-\sigma_N}{2}\Bigg(q^*_{i'N} - q^*_{-i'N} + (1+\alpha_{i'})\left(\frac{\partial q^*_{i'N}}{\partial a^*_{i'N}}\frac{\partial a^*_{i'N}}{\partial \alpha_{i'}} + \frac{\partial q^*_{i'N}}{\partial a^*_{-i'N}}\frac{\partial a^*_{-i'N}}{\partial \alpha_{i'}} + \frac{\partial q^*_{i'N}}{\partial a^*_{CN}}\frac{\partial a^*_{CN}}{\partial \alpha_{i'}}\right) \\ - \alpha_{i'}\left(\frac{\partial q^*_{-i'N}}{\partial a^*_{i'N}}\frac{\partial a^*_{i'N}}{\partial \alpha_{i'}} + \frac{\partial q^*_{-i'N}}{\partial a^*_{-i'N}}\frac{\partial a^*_{-i'N}}{\partial \alpha_{i'}} + \frac{\partial q^*_{-i'N}}{\partial a^*_{CN}}\frac{\partial a^*_{CN}}{\partial \alpha_{i'}}\right)\Bigg)\end{aligned} \tag{33}$$

$$\begin{aligned}\frac{\partial a^*_{i'N}}{\partial \alpha_{-i'}} = \frac{1-\sigma_N}{2}\Bigg((1+\alpha_{i'})\left(\frac{\partial q^*_{i'N}}{\partial a^*_{i'N}}\frac{\partial a^*_{i'N}}{\partial \alpha_{-i'}} + \frac{\partial q^*_{i'N}}{\partial a^*_{-i'N}}\frac{\partial a^*_{-i'N}}{\partial \alpha_{-i'}} + \frac{\partial q^*_{i'N}}{\partial a^*_{CN}}\frac{\partial a^*_{CN}}{\partial \alpha_{-i'}}\right) \\ - \alpha_{i'}\left(\frac{\partial q^*_{-i'N}}{\partial a^*_{i'N}}\frac{\partial a^*_{i'N}}{\partial \alpha_{-i'}} + \frac{\partial q^*_{-i'N}}{\partial a^*_{-i'N}}\frac{\partial a^*_{-i'N}}{\partial \alpha_{-i'}} + \frac{\partial q^*_{-i'N}}{\partial a^*_{CN}}\frac{\partial a^*_{CN}}{\partial \alpha_{-i'}}\right)\Bigg)\end{aligned} \tag{34}$$

Observe that given the choice of $i' \in \{L, R\}$ there are actually four equations for the four unknowns $\frac{\partial q_{i'N}}{\partial a_{i'N}}, \frac{\partial q_{i'N}}{\partial a_{-i'N}}$. Further, note that $\frac{\partial a^*_{CN}}{\partial \alpha_{i'}} = \frac{\partial a^*_{CN}}{\partial \alpha_{-i'}} = 0$ which further simplifies the equations. Hence, on solving these two equations by substituting the values of $\frac{\partial a^*_{i'N}}{\partial \alpha_{i'}}, \frac{\partial a^*_{i'N}}{\partial \alpha_{-i'}}$ throughout, we have the following:

$$\frac{\partial q^*_{i'N}}{\partial a^*_{i'N}} = \frac{\partial q^*_{i'N}}{\partial a^*_{-i'N}} = \frac{1}{2(1-\sigma_N)(\alpha_{i'} - \alpha_{-i'})},$$

$$\frac{\partial q^*_{-i'N}}{\partial a^*_{i'N}} = \frac{\partial q^*_{-i'N}}{\partial a^*_{-i'N}} = \frac{1}{2(1-\sigma_N)(\alpha_{-i'} - \alpha_{i'})}.$$

Using this expression it follows that constructing the elasticity measure is as follows. First, we construct the measure $Q^*_{i'N} = q^*_{i'N} - q^*_{-i'N}$ using the already established equilibrium values. Then, $\frac{\partial Q^*_{i'N}}{\partial a^*_{i'N}} = \frac{\partial q^*_{i'N}}{\partial a^*_{i'N}} - \frac{\partial q^*_{-i'N}}{\partial a^*_{i'N}}$ can be computed using the above derived expressions. Finally, substituting the equilibrium value of $a^*_{i'N}$, we get the expression as follows:

$$\eta_{Ni'} = \frac{a^*_{i'N}}{Q^*_N}\frac{\partial Q^*_{i'N}}{\partial a^*_{i'N}} = \frac{1}{(\alpha_{i'} - \alpha_{-i'})^2}\left(\frac{vk_N}{r_N(1-\sigma_N)^2} + (4 + 2(1+2\alpha_{i'})(\alpha_{i'} - \alpha_{-i'}))\right).$$

Now in order to prove that this elasticity measure is always positive, first consider the expression $Q_{i'N} = q^*_{i'N} - q^*_{-i'N}$ which on substitution from Lemma 1 yields

$$Q^*_{i'N} = \frac{(1-\sigma_N)(\alpha_{i'} - \alpha_{-i'})r_N}{2k_N}.$$

Further, evaluating this expression to derive $\frac{\partial Q^*_{i'N}}{\partial a^*_{i'N}} = \frac{\partial q^*_{i'N}}{\partial a^*_{i'N}} - \frac{\partial q^*_{-i'N}}{\partial a^*_{i'N}}$, yields

$$\frac{\partial Q^*_{i'N}}{\partial a^*_{i'N}} = \frac{\partial q^*_{i'N}}{\partial a^*_{i'N}} - \frac{\partial q^*_{-i'N}}{\partial a^*_{i'N}} = \frac{1}{(1-\sigma_N)(\alpha_{i'} - \alpha_{-i'})}.$$

It follows then that evaluating just the expression $\frac{1}{Q^*_N}\frac{\partial Q^*_{i'N}}{\partial a^*_{i'N}}$ yields

$$\frac{1}{Q^*_N}\frac{\partial Q^*_{i'N}}{\partial a^*_{i'N}} = \frac{2k_N}{r_N(1-\sigma_N)^2(\alpha_{i'} - \alpha_{-i'})^2}$$

which is clearly positive. Multiplying this expression with $a^*_{i'N} > 0$ preserves the positive sign of the expression.

Elasticity on $P_{i'}$: Again, we begin by noting the FOC for partisan website engagement in Stage 2:

$$a^*_{i'P_{i'}} = \frac{1}{2c_{i'P_{i'}}}\left(v + \alpha_{i'}\sigma_{P_{i'}}q_{P^*_{i'}}\right),$$
$$a^*_{-i'P_{i'}} = \frac{1}{2}\left(v - \alpha_{-i'}\sigma_{P_{i'}}q_{P^*_{i'}}\right)$$

In order to derive the derivatives of framing qualities w.r.t engagement levels, we consider the qualities to be functions of engagement levels from L, C, R such that $q^*_{P_{i'}}(a^*_{i'P_{i'}}, a^*_{-i'P_{i'}}, a_{CP_{i'}})$. Now, to generate the simultaneous equations that can help compute the derivatives, we differentiate the above FOCs w.r.t a parameter that is common to both qualities and engagement levels. In this case, that parameter is the polarization degree $\alpha_{i'}$. Therefore differentiating the above FOCs w.r.t $\alpha_{i'}, \alpha_{-i'}$ we have the following equations.

$$\frac{\partial a_{i'P_{i'}}}{\partial \alpha_{i'}} = \frac{\sigma_{P_{i'}}}{2c_{i'P_{i'}}}\left(q^*_{P_{i'}} + \alpha_{i'}\left(\frac{\partial q^*_{P_{i'}}}{\partial a^*_{i'P_{i'}}}\frac{\partial a^*_{i'P_{i'}}}{\partial \alpha_{i'}} + \frac{\partial q^*_{P_{i'}}}{\partial a^*_{-i'P_{i'}}}\frac{\partial a^*_{-i'P_{i'}}}{\partial \alpha_{i'}} + \frac{\partial q^*_{P_{i'}}}{\partial a^*_{CP_{i'}}}\frac{\partial a^*_{CP_{i'}}}{\partial \alpha_{i'}}\right)\right),$$

$$\frac{\partial a_{i'P_{i'}}}{\partial \alpha_{-i'}} = \frac{\sigma_{P_{i'}}}{2c_{i'P_{i'}}}\left(\alpha_{i'}\left(\frac{\partial q^*_{P_{i'}}}{\partial a^*_{i'P_{i'}}}\frac{\partial a^*_{i'P_{i'}}}{\partial \alpha_{-i'}} + \frac{\partial q^*_{P_{i'}}}{\partial a^*_{-i'P_{i'}}}\frac{\partial a^*_{-i'P_{i'}}}{\partial \alpha_{-i'}} + \frac{\partial q^*_{P_{i'}}}{\partial a^*_{CP_{i'}}}\frac{\partial a^*_{CP_{i'}}}{\partial \alpha_{-i'}}\right)\right)$$

Noting that $\frac{\partial a^*_{CP_{i'}}}{\partial \alpha_{i'}} = \frac{\partial a^*_{CP_{i'}}}{\partial \alpha_{-i'}} = 0$ we can solve the above equation to obtain:

$$\frac{\partial q^*_{P_{i'}}}{\partial a^*_{i'P_{i'}}} = \frac{\partial q^*_{P_{i'}}}{\partial a^*_{-i'P_{i'}}} = \frac{2c_{CP}c_{i'P_{i'}}}{\sigma_{P_{i'}}(2c_{CP}\alpha_{i'} - c_{i'P_{i'}}(1 + 2c_{CP}\alpha_{-i'}))}.$$

As before, we use this expression to compute the elasticities and get the following:

$$\eta_{i'P_{i'}} = \frac{a^*_{i'P_{i'}}}{q^*_{P_{i'}}}\frac{\partial q^*_{P_{i'}}}{\partial a^*_{i'P_{i'}}} = \frac{2c_{i'P_{i'}}c_{CP}}{2c_{CP}\alpha_{i'} - c_{i'P_{i'}}(1 + 2c_{CP}\alpha_{-i'})}\left(\alpha_{i'} - \frac{2k_{P_{i'}}vc_{CP}}{\sigma^2_{P_{i'}}r_{P_{i'}}(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(1 + c_{CP}\alpha_{-i'}))}\right)$$

$$\eta_{-i'P_{i'}} = \frac{a^*_{-i'P_{i'}}}{q^*_{P_{i'}}}\frac{\partial q^*_{P_{i'}}}{\partial a^*_{-i'P_{i'}}} = \frac{2c_{i'P_{i'}}c_{CP}}{2c_{CP}\alpha_{i'} - c_{i'P_{i'}}(1 + 2c_{CP}\alpha_{-i'})}\left(\alpha_{-i'} - \frac{2k_{P_{i'}}vc_{CP}c_{i'P_{i'}}}{\sigma^2_{P_{i'}}r_{P_{i'}}(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(1 + c_{CP}\alpha_{-i'}))}\right).$$

Hence we have derived the elasticities as mentioned in Theorem 1. Now in order to prove that these elasticities are positive, we start by considering the expression for $\frac{\partial q^*_{P_{i'}}}{\partial a^*_{i'P_{i'}}} = \frac{\partial q^*_{P_{i'}}}{\partial a^*_{-i'P_{i'}}} = \frac{2c_{CP}c_{i'P_{i'}}}{\sigma_{P_{i'}}(2c_{CP}\alpha_{i'} - c_{i'P_{i'}}(1+2c_{CP}\alpha_{-i'}))}$. Within this expression, we specifically focus on the expression in the denominator which is $\sigma_{P_{i'}}(2c_{CP}\alpha_{i'} - c_{i'P_{i'}}(1 + 2c_{CP}\alpha_{-i'}))$. Here, note that the expression within brackets $2c_{CP}\alpha_{i'} - c_{i'P_{i'}}(1 + 2c_{CP}\alpha_{-i'})$ can be proven to be positive, as follows. First, by assumption A1, we know that $c_{i'P_{i'}} \in \left(0, \frac{c_{CP}\alpha_{i'}}{1+c_{CP}\alpha_{-i'}}\right)$. Now suppose, by contradiction, we assume $2c_{CP}\alpha_{i'} - c_{i'P_{i'}}(1 + 2c_{CP}\alpha_{-i'}) < 0$. Evaluating this, as follows:

$$\Rightarrow 2c_{CP}\alpha_{i'} - c_{i'P_{i'}}(1 + 2c_{CP}\alpha_{-i'}) < 0$$
$$\Rightarrow c_{i'P_{i'}} > \frac{2c_{CP}\alpha_{i'}}{1 + 2c_{CP}\alpha_{i'}}$$

$$\Rightarrow c_{i'P_{i'}} > \frac{c_{CP}\alpha_{i'}}{\frac{1}{2} + c_{CP}\alpha_{i'}} > \frac{c_{CP}\alpha_{i'}}{1 + c_{CP}\alpha_{-i'}},$$

which is impossible because by A1, we know that $c_{i'P_{i'}} \in \left(0, \frac{c_{CP}\alpha_{i'}}{1+c_{CP}\alpha_{-i'}}\right)$ and evidently, $\frac{c_{CP}\alpha_{i'}}{1+c_{CP}\alpha_{-i'}} < \frac{c_{CP}\alpha_{i'}}{\frac{1}{2}+c_{CP}\alpha_{i'}}$. Hence, $2c_{CP}\alpha_{i'} - c_{i'P_{i'}}(1 + 2c_{CP}\alpha_{-i'}) > 0$. Since this holds, observe that in the elasticity expression, the only term that determines the sign is the derivative since the other terms are proven positive at equilibrium. We therefore have shown that both elasticities are positive. □

L Extensions

A common thread in almost all extensions is relaxing assumptions in the main model. In that spirit, the first main assumption we relax is inclusive consumption. That is, we assume that partisan consumers $i' \in \{L, R\}$ have a choice at the beginning of Stage 2: either consume or not consume from N. This choice is to be made given what they observe - a strictly positive set of framing qualities q_{LN}, q_{RN} set by N. In essence, the sequence of the game is now revised to the following:

The Exclusive Consumption Game:

Stage 0: Nature moves: Newsworthy event occurs.

Stage 1: N, P_L, P_R observe the event and set framing qualities q_{LN}, q_{RN} and q_{P_L}, q_{P_R}.

Stage 2: L, C, R observe framing qualities. C updates beliefs and sets engagement levels on all websites. However, L, R act differently.

- If $q_{LN}, q_{RN} > 0$, L, R decide to update their beliefs and engage with their respective partisan websites, not N.
- If $q_{LN} = q_{RN} = 0$ then L, R update their beliefs and engage with N and their respective partisan websites.
- L does not, in any case, engage with P_R; R does not, in any case, engage with P_L.

Exclusive consumption aims to model two primary news consumption behaviors: (1) selectivity in consumption that influences news framing decisions on websites; (2) extreme opposed-partisan animus that influences echo-chamber formation behaviors. Accordingly, in this case, we assume the following: (1) polarization degrees have a lower bound greater than 0 (i.e., $\frac{c_{i'P_{i'}}}{c_{CP}} < \alpha_{i'} < 1$); (2) polarized consumers have a lower search cost than centrist consumer on their partisan websites (i.e., $c_{i'P_{i'}} < c_{CP} < 1$). However, pitting these consumption behaviors against market structures yields further insights, as explained in the following subsections.

L.1 Exclusive Consumption Oligopoly

Following the usual backward induction approach, we begin in Stage 2 but now consider two distinct scenarios: (I) N sets qualities such that $q_{LN} = q_{RN} = 0$; (II) N sets qualities such that $q_{LN}, q_{RN} > 0$.

Case I: In this case, since N sets zero framing qualities, engagement on N is impacted just by the objective facts presented v. Accordingly, only C engages on N while L, R engages on P_L, P_R respectively. The following Lemma characterizes the equilibrium in this case.

Lemma 3. *At equilibrium, the following are the levels of quality and engagement:*

$$q^*_{i'N} = 0, q^*_{P_{i'}} = \frac{r_{P_{i'}}}{k_{P_{i'}}} \left(\frac{(c_{CP}\alpha_{i'} - c_{i'P_{i'}})\sigma_{P_{i'}}}{4c_{CP}c_{i'P_{i'}}} \right),$$

$$a^*_{iN} = \frac{v}{2}, a^*_{i'P_{i'}} = \frac{1}{2c_{i'P_{i'}}} \left(v + \frac{(c_{CP}\alpha_{i'} - c_{i'P_{i'}})r_{P_{i'}}\sigma^2_{P_{i'}}}{4c_{CP}c_{i'P_{i'}}k_{P_{i'}}} \right), a^*_{CP_{i'}} = \frac{1}{2c_{CP}} \left(v - \frac{(c_{CP}\alpha_{i'} - c_{i'P_{i'}})r_{P_{i'}}\sigma^2_{P_{i'}}}{4c_{i'P_{i'}}k_{P_{i'}}} \right).$$

Proof. Setting Stage 1 N framing qualities as zero implies that only partisan consumers are setting engagement qualities in Stage 2, along with centrist consumers, on partisan websites. Therefore, the first-order conditions for Stage 2 are as follows:

$$\begin{aligned} a_{i'P_{i'}} &= \frac{1}{2c_{i'P_{i'}}} \left(v + \sigma_{P_{i'}}\alpha_{i'}q_{P_{i'}} \right) \\ a_{CP_{i'}} &= \frac{1}{2c_{CP}} \left(v - \sigma_{P_{i'}}q_{P_{i'}} \right). \end{aligned}$$

Accordingly, using this for the first stage problem, only partisan websites are solving for optimal best-response framing qualities. Hence, solving for those qualities using Stage 2 engagements as derived yields:

$$q^*_{P_{i'}} = \frac{r_{P_{i'}}}{k_{P_{i'}}} \left(\frac{(c_{CP}\alpha_{i'} - c_{i'P_{i'}})\sigma_{P_{i'}}}{4c_{CP}c_{i'P_{i'}}} \right).$$

Hence, now we can substitute these optimal qualities throughout and obtain the equilibrium values as stated in the Lemma 3. $\square$

Case II: In this case, since N sets strictly positive framing qualities, engagement on N is determined by C only. L, R choose not to engage. Therefore N's problem is setting engagement levels for maximizing C's engagement while each partisan website aims to maximize the engagement of their partisan consumer. The following lemma characterizes the equilibrium for this case.

Lemma 4. *At equilibrium, the following are the levels of quality and engagement:*

$$
\begin{aligned}
& q_{i'N}^{*} = \frac{(1-\sigma_N) r_N}{4k_N}, q_{P_{i'}}^{*} = \frac{r_{P_{i'}}}{k_{P_{i'}}} \left(\frac{(c_{CP}\alpha_{i'} - c_{i'P_{i'}})\sigma_{P_{i'}}}{4c_{CP}c_{i'P_{i'}}} \right), \\
& a_{CN}^{*} = \frac{1}{2} \left(v + \frac{r_N(1-\sigma_N)^2}{2k_N} \right), a_{CP_{i'}}^{*} = \frac{1}{2c_{CP}} \left(v - \frac{(c_{CP}\alpha_{i'} - c_{i'P_{i'}}) r_{P_{i'}} \sigma_{P_{i'}}^2}{4c_{i'P_{i'}} k_{P_{i'}}} \right), \\
& a_{i'P_{i'}}^{*} = \frac{1}{2c_{i'P_{i'}}} \left(v + \frac{(c_{CP}\alpha_{i'} - c_{i'P_{i'}}) r_{P_{i'}} \sigma_{P_{i'}}^2}{4c_{CP}c_{i'P_{i'}} k_{P_{i'}}} \right).
\end{aligned}
$$

Proof. The first-order conditions for Stage 2 are:

$$
\begin{aligned}
a_{i'P_{i'}} &= \frac{1}{2c_{i'P_{i'}}} \left(v + \sigma_{P_{i'}} \alpha_{i'} q_{P_{i'}} \right) \\
a_{CP_{i'}} &= \frac{1}{2c_{CP}} \left(v - \sigma_{P_{i'}} q_{P_{i'}} \right), \\
a_{CN} &= \frac{1}{2} \left(v - (1-\sigma_N)(q_{i'N} + q_{-i'N}) \right)
\end{aligned}
$$

Substituting these into Stage 1, we can solve for the optimal first-stage qualities and obtain the following:

$$
q_{i'N}^{*} = \frac{(1-\sigma_N) r_N}{4k_N}, q_{P_{i'}}^{*} = \frac{r_{P_{i'}}}{k_{P_{i'}}} \left(\frac{(c_{CP}\alpha_{i'} - c_{i'P_{i'}})\sigma_{P_{i'}}}{4c_{CP}c_{i'P_{i'}}} \right).
$$

Thus, substituting this back into the second stage engagement levels gives the following:

$$
\begin{aligned}
& a_{CN}^{*} = \frac{1}{2} \left(v + \frac{r_N(1-\sigma_N)^2}{2k_N} \right), a_{CP_{i'}}^{*} = \frac{1}{2c_{CP}} \left(v - \frac{(c_{CP}\alpha_{i'} - c_{i'P_{i'}}) r_{P_{i'}} \sigma_{P_{i'}}^2}{4c_{i'P_{i'}} k_{P_{i'}}} \right), \\
& a_{i'P_{i'}}^{*} = \frac{1}{2c_{i'P_{i'}}} \left(v + \frac{(c_{CP}\alpha_{i'} - c_{i'P_{i'}}) r_{P_{i'}} \sigma_{P_{i'}}^2}{4c_{CP}c_{i'P_{i'}} k_{P_{i'}}} \right).
\end{aligned}
$$

which is as stated in Lemma 4. □

Here, we now turn to an analysis of how N's payoff would be impacted given these two cases. In other words, we answer the question: *under what circumstances is N better off setting qualities v. not setting qualities when partisan consumers have a choice*? The following proposition outlines the answer to this question.

Proposition 5. *The neutral outlet is better off framing news when faced with exclusive consumption only when its MRC exceeds a threshold* $\hat{\Theta} = \frac{8v}{(1-\sigma_N)^2}$.

Proof. Consider the equilibrium payoffs in both cases as follows:

$$\pi^*_{N1} = \frac{3r_N v}{2}, \text{ when not framing news}$$
$$\pi^*_{N2} = \frac{r_N}{2}\left(v + \frac{r_N(1-\sigma_N)^2}{4k_N}\right), \text{ when framing news.}$$

Now, in order to derive the range for MRC, we consider analyzing the following inequality:

$$\begin{aligned}
&\pi^*_{N1} < \pi^*_{N2}, \\
\Rightarrow &\frac{3r_N v}{2} < \frac{r_N}{2}\left(v + \frac{r_N(1-\sigma_N)^2}{4k_N}\right), \\
\Rightarrow &\frac{3r_N v}{2} - \frac{r_N}{2} < \frac{r_N^2(1-\sigma_N)^2}{8k_N}, \\
\Rightarrow &v r_N < \frac{r_N^2(1-\sigma_N)^2}{8k_N}, \\
\Rightarrow &v < \frac{r_N(1-\sigma_N)^2}{8k_N}, \\
\Rightarrow &\frac{r_N}{k_N} > \frac{8v}{(1-\sigma_N)^2}.
\end{aligned}$$

which is as per the derived threshold. □

L.2 Exclusive Consumption Duopoly

Since just one partisan website competes with the neutral website in the duopoly scenario, we denote the neutral website as N and the partisan website as P. Specifically, since C consumes from both neutral and partisan websites while one of the partisan consumers only consumes from the neutral website or does not consume at all, the search costs of the centrist consumer on the partisan website are bounded from below. Accordingly, two cases are considered: (I) N sets strictly positive equilibrium qualities; (II) N does not set any framing quality; reports facts.

Case I: The following lemma characterizes the equilibrium.

Lemma 5. *At equilibrium, the following are the levels of quality and engagement:*

$$q^*_{i'N} = \frac{(1-\sigma_N)r_N}{4k_N}, q^*_P = \frac{r_P}{k_P}\left(\frac{(c_{CP}\alpha_{i'} - c_{i'P})\sigma_P}{4c_{CP}c_{i'P}}\right),$$
$$a^*_{CN} = \frac{1}{2}\left(v + \frac{r_N(1-\sigma_N)^2}{2k_N}\right), a^*_{CP} = \frac{1}{2c_{CP}}\left(v - \frac{(c_{CP}\alpha_{i'} - c_{i'P})r_P\sigma_P^2}{4c_{i'P}k_P}\right),$$
$$a^*_{i'P} = \frac{1}{2c_{i'P}}\left(v + \frac{(c_{CP}\alpha_{i'} - c_{i'P})r_P\sigma_P^2}{4c_{CP}c_{i'P}k_P}\right).$$

Proof. Proof for this lemma follows directly from the one for Lemma 5. Since consumption levels of consumers across websites are not correlated, any consumption that happens on a website has the same equilibrium value given the parameter range. Hence, the proof is not repeated here for brevity. □

Case II: The following lemma characterizes the equilibrium.

Lemma 6. *At equilibrium, the following are the engagement and quality levels:*

$$q^*_{i'N} = 0, q^*_P = \frac{r_P}{k_P}\left(\frac{(c_{CP}\alpha_{i'} - c_{i'P})\sigma_P}{4c_{CP}c_{i'P}}\right),$$
$$a^*_{iN} = \frac{v}{2}, a^*_{i'P} = \frac{1}{2c_{i'P}}\left(v + \frac{(c_{CP}\alpha_{i'} - c_{i'P})r_P\sigma_P^2}{4c_{CP}c_{i'P}k_P}\right), a^*_{CP} = \frac{1}{2c_{CP}}\left(v - \frac{(c_{CP}\alpha_{i'} - c_{i'P})r_P\sigma_P^2}{4c_{i'P}k_P}\right).$$

Proof. Proof for this lemma follows directly from the one for Lemma 4. Since consumption levels of consumers across websites are not correlated, any consumption that happens on a website has the same equilibrium value given the parameter range. Hence, the proof is not repeated here for brevity. □

Note that since equilibrium values are exactly the same, the only other analysis is the payoffs for neutral websites between cases I and II. Since equilibrium is characterized as similar to the oligopoly case, the insight from Proposition 5 holds.

L.3 Inclusive Consumption Duopoly

In order to derive the equilibrium qualities and engagements, we assume P is left-aligned WLOG, use the traditional backward induction and begin in Stage 2. Note that each consumer i solves the utility maximization problem when consuming from N and P with finite attention $\varphi_i \in (0, 1)$ dedicated to N. Since the consumption utilities are concave in a_{iN} and a_{iP}, the first-order conditions give the optimum engagement by the concavity property.

That is, the sub-game perfect engagement levels are:

$$a_{LN} = \frac{1}{2}\left(v + (1-\sigma_N)((\alpha_L+1)q_{LN} - \alpha_L q_{RN})\right), \tag{35}$$

$$a_{RN} = \frac{1}{2}\left(v - (1-\sigma_N)((\alpha_R+1)q_{RN} - \alpha_R q_{LN})\right) \tag{36}$$

$$a_{LP} = \frac{1}{2c_{LP}}\left(v + \alpha_L \sigma_P q_{LP}\right), \tag{37}$$

$$a_{RP} = \frac{1}{2c_{RP}}\left(v - \alpha_R \sigma_P q_{LP}\right), \tag{38}$$

$$a_{CN} = \frac{1}{2}\left(v + (1-\sigma_N)\left(q_{LN} + q_{RN}\right)\right), \tag{39}$$

$$a_{CP} = \frac{1}{2c_{CP}}\left(v - \sigma_P q_{LP}\right). \tag{40}$$

Given these engagement levels, in Stage 1, N and P simultaneously set framing qualities $\{q_{LN}, q_{RN}\}$ and q_{LP}, respectively, to maximize payoffs from engagement. Again, we note that the concave nature of π_N, π_P implies that the first order conditions will be the solution to maximizing payoffs, and so, substituting equations into equations, differentiating π_N with respect to q_{LN}, q_{RN} and π_P with respect to q_{LP}, we get the following optimal framing qualities:

$$q^*_{LN} = \frac{r_N(1-\sigma_N)(2+\alpha_L-\alpha_R)}{4k_N} \tag{41}$$

$$q^*_{RN} = \frac{r_N(1-\sigma_N)(2+\alpha_R-\alpha_L)}{4k_N} \tag{42}$$

$$q^*_{LP} = \frac{\sigma_P r_P(c_{CP}c_{RP}\alpha_L - c_{LP}(c_{CP}\alpha_R + c_{RP}))}{4c_{CP}c_{LP}c_{RP}k_P}. \tag{43}$$

where observe that since our search cost assumptions are:

$$E1 : c_{CP} \in \left(\frac{c_{LP}c_{RP}}{c_{RP}\alpha_L - c_{LP}\alpha_R}, 1\right),$$
$$E2 : c_{LP} \in \left(0, \frac{\alpha_L c_{RP}}{c_{RP} + \alpha_R}\right),$$
$$E3 : c_{RP} \in (0, 1).$$

the parameter assumptions which are:

$$E4 : \gamma_j, \beta_j \in (0, 1),$$

$$E5 : \alpha_i \in (0, 1),$$

$\forall\, i \in \{L, C, R\}, j \in \{N, P\}$ and finally, the MRC of partisan website P is

$$E6 : \frac{r_P}{k_P} < \frac{4c_{CP}c_{LP}c_{RP}k_P}{\sigma_P r_P(c_{CP}c_{RP}\alpha_L - c_{LP}(c_{CP}\alpha_R + c_{RP}))}.$$

help ensure that $q^*_{LP} > 0$ and $q^*_{LN}, q^*_{RN} > 0$.

Now, having obtained the Stage 1 equilibrium framing qualities, in order to derive the Stage 2 (sub-game perfect) engagement levels, we substitute these framing qualities back into equations 5-10 and obtain the following:

$$a_{i'N} = \frac{1}{2}\left(\frac{r_N(1-\sigma_N)^2\,(2 + (\alpha_{i'} - \alpha_{-i'})(1 + 2\alpha_{i'}))}{4k_N} + v\right)\,, i \neq -i',\ \forall\, i', -i'\{L, R\}. \tag{44}$$

$$a_{i'P} = \frac{1}{2c_{i'P}}\left(v + (-1)^{\xi(i')}\alpha_{i'}q^*_P\right), \xi(i') = \begin{cases} 1, & i' = R \\ 2, & i' = L \end{cases}. \tag{45}$$

$$a^*_{CN} = \frac{1}{2}\left(\frac{r_N(1-\sigma_N)^2}{k_N} + v\right), \tag{46}$$

$$a^*_{CP} = \frac{1}{2c_{CP}}\left(v - q^*_P\right). \tag{47}$$

where under assumptions E1-E6, all the engagement levels derived are strictly positive.

In order to prove the existence of equilibrium with these derived values, we consider the following numeric values of framing qualities and engagements, associated payoffs for N, P:

Parameter Values – note that these values satisfy E1 - E6:

$$\{v \to \tfrac{1}{4}, k_N \to 1, k_P \to 1, r_P \to 1, r_P \to 1, c_{LP} \to \tfrac{1}{16}, c_{RP} \to \tfrac{1}{2}, c_{CP} \to \tfrac{5}{8}, \gamma_N \to \tfrac{1}{2}, \gamma_P \to \tfrac{1}{2}, \beta_N \to \tfrac{1}{2}, \beta_P \to \tfrac{1}{2}, \alpha_L \to \tfrac{1}{4}, \alpha_R \to \tfrac{1}{2}, \varphi_i \to \tfrac{1}{2}\forall i \in \{L, C, R\}\}$$

Equilibrium Values:

$$\begin{aligned}
&q^*_{LN} = \frac{7}{48}, q^*_{RN} = \frac{3}{16}, q^*_{LP} = q^*_{RN} = \frac{7}{30} \\
&a^*_{LN} = \frac{85}{576}, a^*_{RN} = \frac{23}{144}, a^*_{CN} = \frac{13}{72} \\
&a^*_{LP} = \frac{104}{45}, a^*_{RP} = \frac{31}{180}, a^*_{CP} = \frac{17}{225}, \\
&\pi^*_N = \frac{497}{1152}, \pi^*_P = \frac{1127}{450},
\end{aligned}$$

$$u_L^* = \frac{2949521}{16588800}, u_R^* = \frac{6971}{345600}, u_C^* = \frac{23437}{1296000}.$$

Hence, we have shown numerically and analytically that our derived interior equilibrium holds under the conditions of E1-E6.

Using these equilibrium qualities, the following insights can be derived, as mentioned in Table 3.

Proposition 6. *Under the interior equilibrium, the following hold:*

I. Even if consumers think the partisan website is left-leaning, increasingly polarized right-leaning partisans can increase engagement by increasing leveling or by reducing sharpening tendencies.

II. Even if partisan customers believe a news outlet is neutral, increasing partisan polarization may limit their online engagement.

Proof. The proof is given for each part of the proposition as follows:

I. We begin the proof by noting the expressions for the two derivatives mentioned $\frac{\partial^2 a_{RP}^*}{\partial \alpha_R \partial \gamma_P}$ and $\frac{\partial^2 a_{RP}^*}{\partial \alpha_R \partial \beta_P}$.

$$\frac{\partial^2 a_{RP}^*}{\partial \alpha_R \partial \gamma_P} = \frac{\beta_P \gamma_P r_P (c_{LP}(2c_{CP}\alpha_R + c_{RP}) - c_{CP}c_{RP}\alpha_L)}{4c_{CP}c_{LP}c_{RP}^2 k_P(\beta_P(1-\gamma_P) + \gamma_P)^3}$$

$$\frac{\partial^2 a_{RP}^*}{\partial \alpha_R \partial \beta_P} = -\frac{(1-\gamma_P)\beta_P \gamma_P r_P (c_{LP}(2c_{CP}\alpha_R + c_{RP}) - c_{CP}c_{RP}\alpha_L)}{4c_{CP}c_{LP}c_{RP}^2 k_P(\beta_P(1-\gamma_P) + \gamma_P)^3}$$

We use assumptions E1-E6 and consider simplifying the above expressions. Considering both the derived expressions above, it is clear that the expression $(c_{LP}(2c_{CP}\alpha_R + c_{RP}) - c_{CP}c_{RP}\alpha_L)$ in the numerator is crucial in determining the sign of the derivative. We therefore focus on establishing a region of α_R for a given value of α_L as follows.

$$\begin{aligned}
\frac{\partial^2 a_{RP}^*}{\partial \alpha_R \partial \gamma_P} > 0 &\Rightarrow (c_{LP}(2c_{CP}\alpha_R + c_{RP}) - c_{CP}c_{RP}\alpha_L) > 0 \\
&\Rightarrow c_{LP}(2c_{CP}\alpha_R + c_{RP}) > c_{CP}c_{RP}\alpha_L \\
&\Rightarrow (2c_{CP}\alpha_R + c_{RP}) > c_{CP}c_{RP}\frac{\alpha_L}{c_{LP}} \\
&\Rightarrow 2c_{CP}\alpha_R > c_{CP}c_{RP}\frac{\alpha_L}{c_{LP}} - c_{RP} \\
&\Rightarrow \alpha_R > c_{RP}\frac{\alpha_L}{2c_{LP}} - \frac{c_{RP}}{2c_{CP}} \\
&\Rightarrow \alpha_R > \frac{c_{RP}}{2}\left(\frac{\alpha_L}{c_{LP}} - \frac{1}{c_{CP}}\right).
\end{aligned}$$

This establishes a lower bound of α_R. However, observe that assumptions E1-E3 imply that necessarily $c_{iP} \leq 1, i \in \{L, C, R\}$. We, therefore, use assumptions E1-E3 (bounds on c_{CP}, c_{RP}, c_{LP}) and establish an upper bound of α_R as follows. We begin by considering the expression for $\frac{\partial a^*_{RP}}{\partial \alpha_R}$ again, but this time we solve for c_{CP}, as follows.

$$\Rightarrow (c_{LP}(2c_{CP}\alpha_R + c_{RP}) - c_{CP}c_{RP}\alpha_L) > 0$$
$$\Rightarrow c_{CP} < \frac{c_{LP}c_{RP}}{c_{RP}\alpha_L - 2c_{LP}\alpha_R}$$

Observe that the RHS of the above inequality, following assumption E1, must be less than 1, implying that $\frac{c_{LP}c_{RP}}{c_{RP}\alpha_L - 2c_{LP}\alpha_R} \leq 1 \Rightarrow \alpha_R \leq \frac{c_{RP}}{2}\left(\frac{\alpha_L}{c_{LP}} - 1\right)$. Hence, the entire region of α_R is simply

$$\left(\frac{c_{RP}}{2}\left(\frac{\alpha_L}{c_{LP}} - \frac{1}{c_{CP}}\right), \frac{c_{RP}}{2}\left(\frac{\alpha_L}{c_{LP}} - 1\right)\right)$$

for which we can conclude that $\frac{\partial^2 a^*_{RP}}{\partial \alpha_R \partial \gamma_P} \geq 0$ and $\frac{\partial^2 a^*_{RP}}{\partial \alpha_R \partial \beta_P} < 0$.

II. We begin the proof by noting the following expressions for $\frac{\partial a^*_{iP}}{\partial \beta_P}, \frac{\partial a^*_{iP}}{\partial \gamma_P}, \frac{\partial a^*_{iN}}{\partial \beta_N}, \frac{\partial a^*_{iN}}{\partial \gamma_N}, i \in \{L, C, R\}$. First, consider $\frac{\partial a^*_{iN}}{\partial \beta_N}$ as follows:

$$\frac{\partial a^*_{LN}}{\partial \beta_N} = \frac{\beta_N(1-\gamma_N)^2\gamma_N r_N\left(2\alpha_L^2 - 2\alpha_L\alpha_R + \alpha_L - \alpha_R + 2\right)}{4k_N(\beta_N(1-\gamma_N)+\gamma_N)^3}$$
$$\frac{\partial a^*_{RN}}{\partial \beta_N} = -\frac{\beta_N(1-\gamma_N)^2\gamma_N r_N(2\alpha_L\alpha_R + \alpha_L - \alpha_R(2\alpha_R+1) - 2)}{4k_N(\beta_N(1-\gamma_N)+\gamma_N)^3}$$
$$\frac{\partial a^*_{CN}}{\partial \beta_N} = \frac{\beta_N(1-\gamma_N)^2\gamma_N r_N}{k_N(\beta_N(1-\gamma_N)+\gamma_N)^3}$$

Second, consider $\frac{\partial a^*_{iN}}{\partial \gamma_N}$ as follows:

$$\frac{\partial a^*_{LN}}{\partial \gamma_N} = -\frac{\beta_N^2(1-\gamma_N)r_N\left(2\alpha_L^2 - 2\alpha_L\alpha_R + \alpha_L - \alpha_R + 2\right)}{4k_N(\beta_N(1-\gamma_N)+\gamma_N)^3}$$
$$\frac{\partial a^*_{RN}}{\partial \gamma_N} = \frac{\beta_N^2(1-\gamma_N)r_N(2\alpha_L\alpha_R + \alpha_L - \alpha_R(2\alpha_R+1) - 2)}{4k_N(\beta_N(1-\gamma_N)+\gamma_N)^3}$$
$$\frac{\partial a^*_{CN}}{\partial \gamma_N} = -\frac{\beta_N^2(1-\gamma_N)r_N}{k_N(\beta_N(1-\gamma_N)+\gamma_N)^3}$$

Third, consider $\frac{\partial a^*_{iP}}{\partial \beta_P}$ as follows:

$$\frac{\partial a^*_{LP}}{\partial \beta_P} = \frac{\alpha_L(1-\gamma_P)\gamma_P^2 r_P(c_{LP}(c_{CP}\alpha_R + c_{RP}) - c_{CP}c_{RP}\alpha_L)}{4c_{CP}c_{LP}^2 c_{RP}k_P(\beta_P(1-\gamma_P)+\gamma_P)^3}$$
$$\frac{\partial a^*_{RP}}{\partial \beta_P} = -\frac{\alpha_R(1-\gamma_P)\gamma_P^2 r_P(c_{LP}(c_{CP}\alpha_R + c_{RP}) - c_{CP}c_{RP}\alpha_L)}{4c_{CP}c_{LP}c_{RP}^2 k_P(\beta_P(1-\gamma_P)+\gamma_P)^3}$$
$$\frac{\partial a^*_{CP}}{\partial \beta_P} = -\frac{(1-\gamma_P)\gamma_P^2 r_P(c_{LP}(c_{CP}\alpha_R + c_{RP}) - c_{CP}c_{RP}\alpha_L)}{4c_{CP}^2 c_{LP}c_{RP}k_P(\beta_P(1-\gamma_P)+\gamma_P)^3}$$

Finally, consider $\frac{\partial a^*_{iP}}{\partial \gamma_P}$ as follows:

$$\frac{\partial a^*_{LP}}{\partial \gamma_P} = -\frac{\alpha_L\beta_P\gamma_P r_P(c_{LP}(c_{CP}\alpha_R + c_{RP}) - c_{CP}c_{RP}\alpha_L)}{4c_{CP}c_{LP}^2 c_{RP}k_P(\beta_P(1-\gamma_P)+\gamma_P)^3}$$
$$\frac{\partial a^*_{RP}}{\partial \gamma_P} = \frac{\alpha_R\beta_P\gamma_P r_P(c_{LP}(c_{CP}\alpha_R + c_{RP}) - c_{CP}c_{RP}\alpha_L)}{4c_{CP}c_{LP}c_{RP}^2 k_P(\beta_P(1-\gamma_P)+\gamma_P)^3}$$
$$\frac{\partial a^*_{CP}}{\partial \gamma_P} = \frac{\beta_P\gamma_P r_P(c_{LP}(c_{CP}\alpha_R + c_{RP}) - c_{CP}c_{RP}\alpha_L)}{4c_{CP}^2 c_{LP}c_{RP}k_P(\beta_P(1-\gamma_P)+\gamma_P)^3}$$

Observe that in the derivatives for engagement levels on P, we can isolate terms within the expressions and in turn, rewrite the expressions using Γ (refer to assumption E6). That is, the following are the derivatives of engagement levels on P, with respect to β_P, γ_P, respectively:

$$\frac{\partial a^*_{LP}}{\partial \beta_P} = -\left(\frac{\alpha_L(1-\gamma_P)}{c_{LP}(\beta_P(1-\gamma_P)+\gamma_P)}\right)\Gamma$$
$$\frac{\partial a^*_{RP}}{\partial \beta_P} = \left(\frac{\alpha_R(1-\gamma_P)}{c_{RP}(\beta_P(1-\gamma_P)+\gamma_P)}\right)\Gamma$$
$$\frac{\partial a^*_{CP}}{\partial \beta_P} = \left(\frac{(1-\gamma_P)}{c_{CP}(\beta_P(1-\gamma_P)+\gamma_P)}\right)\Gamma$$
$$\frac{\partial a^*_{LP}}{\partial \gamma_P} = \left(\frac{\alpha_L\beta_P}{\gamma_P c_{LP}(\beta_P(1-\gamma_P)+\gamma_P)}\right)\Gamma$$
$$\frac{\partial a^*_{RP}}{\partial \gamma_P} = -\left(\frac{\alpha_R\beta_P}{\gamma_P c_{RP}(\beta_P(1-\gamma_P)+\gamma_P)}\right)\Gamma$$
$$\frac{\partial a^*_{CP}}{\partial \gamma_P} = -\left(\frac{\beta_P}{\gamma_P c_{CP}(\beta_P(1-\gamma_P)+\gamma_P)}\right)\Gamma$$

where $\Gamma = \frac{\gamma_P^2 r_P(c_{CP}c_{RP}\alpha_L - c_{LP}(c_{CP}\alpha_R + c_{RP}))}{4c_{CP}c_{LP}c_{RP}k_P(\beta_P(1-\gamma_P)+\gamma_P)^2} > 0$. Now, under assumptions E1-E6, we can conclude that $\frac{\partial a^*_{RP}}{\partial \beta_P} > 0, \frac{\partial a^*_{CP}}{\partial \beta_P} > 0$ but $\frac{\partial a^*_{LP}}{\partial \beta_P} < 0$. Similarly, $\frac{\partial a^*_{RP}}{\partial \gamma_P} < 0, \frac{\partial a^*_{CP}}{\partial \gamma_P} < 0$ but $\frac{\partial a^*_{LP}}{\partial \gamma_P} > 0$. We now consider the derivative expressions for engagement levels on N as follows. First, note that in the numerators for $\frac{\partial a^*_{LN}}{\partial \beta_N}$ and $\frac{\partial a^*_{LN}}{\partial \gamma_N}$, the expression that will determine the sign of the derivative is simply

$$\left(2\alpha_L^2 - 2\alpha_L\alpha_R + \alpha_L - \alpha_R + 2\right).$$

This expression can be further simplified as follows:

$$\begin{aligned}
&\Rightarrow \left(2\alpha_L^2 - 2\alpha_L\alpha_R + \alpha_L - \alpha_R + 2\right) \\
&\Rightarrow 2\alpha_L(\alpha_L - \alpha_R) + (\alpha_L - \alpha_R) + 2 \\
&\Rightarrow (\alpha_L - \alpha_R)(1 + 2\alpha_L) + 2.
\end{aligned}$$

Under assumption A5, $(\alpha_L - \alpha_R)(1 + 2\alpha_L) + 2 > 0$ which implies that $\frac{\partial a^*_{LN}}{\partial \beta_N} > 0$ and $\frac{\partial a^*_{LN}}{\partial \gamma_N} < 0$. Second, note that the in the numerators for $\frac{\partial a^*_{RN}}{\partial \beta_N}$ and $\frac{\partial a^*_{RN}}{\partial \gamma_N}$, the expression that will determine sign of the derivative is simply

$$(2\alpha_L\alpha_R + \alpha_L - \alpha_R(2\alpha_R + 1) - 2).$$

This expression can be further simplified as follows:

$$\begin{aligned}
&\Rightarrow 2\alpha_L\alpha_R + \alpha_L - \alpha_R(2\alpha_R + 1) - 2 \\
&\Rightarrow 2\alpha_R(\alpha_L - \alpha_R) + (\alpha_L - \alpha_R) - 2 \\
&\Rightarrow (\alpha_L - \alpha_R)(1 + 2\alpha_R) - 2.
\end{aligned}$$

Under assumption A5, $(\alpha_L - \alpha_R)(1 + 2\alpha_R) - 2 < 0$ which implies that $\frac{\partial a^*_{RN}}{\partial \beta_N} > 0$ and $\frac{\partial a^*_{RN}}{\partial \gamma_N} < 0$. Finally, note that for $\frac{\partial a^*_{CN}}{\partial \beta_N}$ and $\frac{\partial a^*_{CN}}{\partial \gamma_N}$, under assumption A4, it follows that $\frac{\partial a^*_{CN}}{\partial \beta_N} > 0$ and $\frac{\partial a^*_{CN}}{\partial \gamma_N} < 0$. We have therefore proved all the results as set out in Proposition 6. $\square$

L.4 Aversion Dominates Affinity

We begin this section by noting that only under inclusive consumption aversion dominating affinity to some degree can be considered a non-trivial case. Exclusive consumption leads to a scenario where partisans opt not to consume, displaying a significant aversion and a lack of affinity towards the product. Hence, we consider the inclusive oligopoly case to motivate the results, which hold for the duopoly case.

Lemma 7. *At equilibrium, when aversion dominates affinity, the neutral outlet can set either L or R aligned framing qualities, but not both.*

Proof. Recall that the utilities consider affinity as $\hat{\mu}_{\text{aff}} = 1 + \alpha_{i'}$ and aversion as $\hat{\mu}_{\text{ave}} = \alpha_{i'}$. Now, we revise these definitions to be affinity as $\hat{\mu}_{\text{aff}} = \alpha_{i'}$ and aversion as $\hat{\mu}_{\text{ave}} = 1 + \alpha_{i'}$. Revisiting the Stage 2 quantities, we have the following expressions:

$$a_{LN} = \frac{1}{2}\left(v + \frac{\beta_N(1-\gamma_N)(-(\alpha_L+1)q_{RN} + \alpha_L q_{LN})}{\beta_N(1-\gamma_N)+\gamma_N}\right), \tag{48}$$

$$a_{RN} = \frac{1}{2}\left(v - \frac{\beta_N(1-\gamma_N)(\alpha_R q_{RN} - (\alpha_R+1)q_{LN})}{\beta_N(1-\gamma_N)+\gamma_N}\right) \tag{49}$$

$$a_{i'P_{i'}} = \frac{v + \frac{\alpha_{i'}\gamma_{P_{i'}}q_{i'P_{i'}}}{\beta_{P_{i'}}(1-\gamma_{P_{i'}})+\gamma_{P_{i'}}}}{2c_{i'P_{i'}}}, \tag{50}$$

$$a_{i'P_{-i'}} = \frac{v - \frac{\alpha_{i'}\gamma_{P_{-i'}}q_{P_{-i'}}}{\beta_{P_{-i'}}(1-\gamma_{P_{-i'}})+\gamma_{P_{-i'}}}}{2}, \tag{51}$$

$$a_{CN} = \frac{1}{2}\left(v + \left(1 - \frac{\gamma_N}{\beta_N(1-\gamma_N)+\gamma_N}\right)(q_{LN}+q_{RN})\right), \tag{52}$$

$$a_{CP_{i'}} = \frac{v + \frac{\gamma_{P_{i'}}q_{P_{i'}}}{\beta_{P_{i'}}(1-\gamma_{P_{i'}})+\gamma_{P_{i'}}}}{2c_{CP}}, \tag{53}$$

note that engagement levels on N for consumers L, R now have higher aversion than affinity.

Using these in Stage 1 and simplifying the expressions, we get the following qualities at equilibrium:

$$q^*_{LN} = \frac{(1-\sigma_N)(\alpha_L - \alpha_R)r_N}{4k_N},$$
$$q^*_{RN} = \frac{(1-\sigma_N)(\alpha_R - \alpha_L)r_N}{4k_N},$$
$$q^*_{P_{i'}} = \frac{r_{P_{i'}}}{k_{P_{i'}}}\left(\frac{\sigma_{P_{i'}}(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'}+1))}{4c_{CP}c_{i'P_{i'}}}\right).$$

Here, note that only one of q^*_{LN} and q^*_{RN} can be positive, not both. This is because both $\alpha_L, \alpha_R \in (0,1)$ and given whichever degree dominates the other, one of $q^*_{LN} > 0$ or $q^*_{RN} > 0$. Hence, the equilibrium quality setting for N depends on which consumer is more polarized. Further, by setting a positive framing quality for the more polarized consumer, N essentially postures as a partisan website. □

L.5 Equilibrium without Pure Centrist Partisan

Center-left or -right partisan alignment is important for quality-setting equilibrium. While pure centrism rejects all biased news, center-left (and center-right), partisanship incentivizes the partisan website to more aggressively set qualities now that C is a potential partisan consumer. We, therefore, analyze this scenario as an extension of our base model. Without loss of generality, we consider a center-left (indexed cl) centrist and note that due to symmetry, a similar analysis can be done for a center-right centrist without impacting equilibrium results. The following proposition characterizes the equilibrium qualities $\{q^*_{LN,cl}, q^*_{RN,cl}\}, q^*_{P_L,cl}, q^*_{P_R,cl}$ and engagements $a^*_{ij,cl}, i \in \{L, C, R\}, j \in \{N, P\}$. More importantly, our analysis points out how the quality and engagement change when C develops some form of partisan leaning and the 'center does not hold.' Accordingly, building on base model assumptions A1-A6 (see proof of Lemma 1 in Section E), we assume: (1) A1 only holds for R such that $c_{P_R} \in \left(0, \frac{c_{CP}\alpha_R}{\frac{\alpha_L}{2} + c_{CP}\alpha_L}\right)$. (2) We assume the center-left centrist as having a lower polarization degree than L, such that $\alpha_{CN} = 1, \alpha_{CP_{i'}} = \frac{\alpha_L}{2}$. (3) We consider the left-leaning partisans as having a lower bound on their polarization degree ($\alpha_L \in \left(\frac{2\alpha_R}{3}, 1\right)$) compared to R ($\alpha_R \in (0, 1)$). This models a consumption scenario with left-leaning consumers more sensitive to partisan news not because of search costs but because of their polarization degree.

Proposition 7. *In the presence of a center-left centrist, the neutral news website does not change its equilibrium quality setting. However, the partisan websites P_L, P_R change their quality settings such that:*

$$q^*_{P_L,cl} = \frac{\sigma_{P_L} r_{P_L}(2c_{CP}(\alpha_L - c_{P_L}\alpha_R) + c_{P_L}\alpha_L)}{8c_{CP}c_{P_L}k_{P_L}},$$
$$q^*_{P_R,cl} = \frac{\sigma_{P_R} r_{P_R}(2c_{CP}(\alpha_R - c_{P_R}\alpha_L) - c_{P_R}\alpha_L)}{8c_{CP}c_{P_R}k_{P_R}}.$$

These qualities change from the pure centrist partisan scenario. Specifically, $q^*_{P_L,cl} > q^*_{P_L}$ and $q^*_{P_R,cl} > q^*_{P_R}$, where $q^*_{P_L}, q^*_{P_R}$ are from the pure centrist equilibrium.

Proof. We begin the proof by noting that since the only consumer changing in the market is C, for consumers L and R, the consumption decision problem is the same as in the base model. However, with a new center-left (or -right) C consumer in the market, since preference on $P_{i'}$ changes for C, $P_{i'}$ will set qualities to maximize payoff from engagements that include this news C consumer. So, we demonstrate the optimal quality setting and engagement decisions from the consumption perspective on $P_{i'}$.

First, consider the center-left C. We begin in Stage 2 by noting that since the structure of the consumption utility is still concave, the solution to first-order conditions gives the optimal engagement levels. The first-order conditions for the center-left consumer are as follows:

$$a_{CP_L,cl} = \frac{1}{2c_{CP}}\left(v + \frac{\alpha_L}{2}(\sigma_{P_L} q_{P_L})\right),$$
$$a_{CP_R,cl} = \frac{1}{2c_{CP}}\left(v - \frac{\alpha_L}{2}(\sigma_{P_R} q_{P_R})\right).$$

We then use these engagement levels to solve the Stage 1 problem for P. That is, by solving the first-order condition of $P_{i'}$'s problem of maximizing payoff, we obtain the following optimal quality level:

$$q^*_{P_L,cl} = \frac{\sigma_{P_L} r_{P_L}(2c_{CP}(\alpha_L - c_{P_L}\alpha_R) + c_{P_L}\alpha_L)}{8c_{CP}c_{P_L}k_{P_L}},$$
$$q^*_{P_R,cl} = \frac{\sigma_{P_R} r_{P_R}(2c_{CP}(\alpha_R - c_{P_R}\alpha_L) - c_{P_R}\alpha_L)}{8c_{CP}c_{P_R}k_{P_R}}.$$

Now, comparing this expression to the base model expression, restated her for convenience,

$$q^*_{P_{i'}} = \frac{r_{P_{i'}}}{k_{P_{i'}}}\left(\frac{\sigma_{P_{i'}}(c_{CP}\alpha_{i'} - c_{i'P_{i'}}(c_{CP}\alpha_{-i'}+1))}{4c_{CP}c_{i'P_{i'}}}\right).$$

we can observe that while the denominators are similar, the numerators are different; hence, analyzing the difference between the expressions should suffice. Specifically, consider the following difference between $q^*_{LP,cl}$ and q^*_{LP}:

$$\Rightarrow \frac{\sigma_{P_L} r_{P_L}(2c_{CP}(\alpha_L - c_{P_L}\alpha_R) + c_{P_L}\alpha_L)}{8c_{CP}c_{P_L}k_{P_L}} - \left(\frac{r_{P_L}}{k_{P_L}}\left(\frac{\sigma_{P_L}(c_{CP}\alpha_L - c_{LP_L}(c_{CP}\alpha_R+1))}{4c_{CP}c_{LP_L}}\right)\right),$$
$$\Rightarrow \frac{(2+\alpha_L)\sigma_{P_L} r_{P_L}}{8c_{CP}k_{P_L}} > 0$$

which is clearly greater than zero under both A1-A6 and the assumptions in this extension. Therefore, $q^*_{LP,cl} > q^*_{LP}$.

Next, consider the following difference between $q^*_{RP,cl}$ and q^*_{RP}:

$$\Rightarrow \frac{\sigma_{P_R} r_{P_R}(2c_{CP}(\alpha_R - c_{P_R}\alpha_L) - c_{P_R}\alpha_L)}{8c_{CP}c_{P_R}k_{P_R}} - \left(\frac{r_{P_R}}{k_{P_R}}\left(\frac{\sigma_{P_R}(c_{CP}\alpha_R - c_{RP_R}(c_{CP}\alpha_L+1))}{4c_{CP}c_{RP_R}}\right)\right),$$

$$\Rightarrow \frac{(2-\alpha_L)\sigma_{P_R} r_{P_R}}{8c_{CP} k_{P_R}} > 0$$

which is clearly greater than zero under both A1-A6 and the assumptions in this extension. Therefore, $q^*_{RP,cl} > q^*_{RP}$. $\square$

Essentially, the center-left or -right consumer now engages comparatively more than a pure centrist consumer on $P_{i'}$. Intuitively, two model aspects are driving this result: the pure centrist consumer has a higher affinity-aversion tendency to partisan news than center-left or -right consumers; center-left or center-right consumers have lower affinity-aversion than partisan consumers L, R. This aspect of consumer utility implies that when consuming from $P_{i'}$, a consumer without a pure centrist approach to news is not averse to rival partisan news (center-right) and has some affinity for partisan news (center-left). Such political news preference now incentivizes $P_{i'}$ to set higher quality levels than when facing pure centrist C at equilibrium when competing with N. Notice that although $P_{i'}$ does set a higher quality level, the comparative statics established in Propositions 1-6 for L, R remain the same. That is, since the equilibrium qualities and engagements derived for polarized consumers L, R remain the same, the insights from previous propositions remain the same too.

Importantly, Proposition 7 shows the implications of losing a pure centrist consumer in the market and having them replaced by center-right/-left partisans. As mentioned previously, the center-left or -right setting allows us to explore what happens when the ‘center does not hold’ – when polarization increases such that C shifts from the center towards either partisan side. We show that with such a loss of the center, as the polarization of partisans (L, R) increases, center-left or -right partisans’ consumption on $P_{i'}$ reflects increasing affinity to partisan news. For instance, in the presence of a center-right partisan, $P_{i'}$ is well aware that C will now prefer consuming from N than $P_{i'}$. However, since the aversion to left-leaning news is lesser than when C is pure centrist, $P_{i'}$ is incentivized to set a higher quality level now than before. Consequently, C’s engagement on $P_{i'}$ also increases, and more broadly, when center-left, C engages the most with $P_{i'}$, and when center-right, engages the least with $P_{i'}$. In essence, serving news to consumers in a market where some consumers exhibit pure centrist ideology is the worst outcome for $P_{i'}$ compared to the scenario where most consumers are politically aligned with L or R to some degree. While evidenced through parametric assumptions in our model, our finding does have some practical relevance.

Considering the center-left or center-right consumers as moderates (i.e., moderate voters as in elections), Proposition 7 insights become more relevant. Over the past 30 years, Gallup’s yearly surveys have found that 4 in 10 Americans are moderate (conservatives are smaller and have dropped in numbers, while liberals have expanded) [75]. Even so, moderate voters' motivations are often a contested area. One theory suggests that moderates may not care about politics or have consistent beliefs. Another says the center is full of liberal and conservative people, making them tough to define or appeal to politically. According to UC San Diego political scientist Seth Hill, moderates may not understand current events or share the majority's views [31]. However, [40] has shown that all these answers are partially correct. Most Americans hold left-to-right viewpoints. Moderate voters can still influence elections. Moderates transform electoral accountability. Moderates respond more to candidate attributes than lever-pulling liberals and conservatives. They are four to five times more responsive to candidates' ideology, incumbency, and experience than liberals and conservatives in U.S. House elections.

Therefore, the media's strategy when attracting engagement from moderates may only sometimes follow partisan lines. As Proposition 7 shows, even when a moderate consumer has a center-right leaning, a left-leaning news website may increase the quality levels of its reporting more than when facing a pure centrist consumer, enough to attract engagement. Since online news consumption implies an increased awareness of the pros and cons of different political parties, consumers are less uncertain about partisan positions in the news. This clarity on partisan framing of news drives framing effects towards a 'political sorting' where like-minded partisans increase engagement [50]. In our model, such sorting is evident through the higher engagement of center-left C than center-right C on $P_{i'}$. Because of this sorting, news media now appear perceptibly more 'open' to consumers in the middle of the political spectrum. Proposition 7 explains how such perceptions translate to engagements for partisan news media.