News Sharing, Gatekeeping, and Polarization: A study of the #Bolsonaro Election

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Abstract

The increasing importance of news sharing, and its effect on the routines, practices, and values described by the hierarchy of influences model, raises new questions about content creation in polarized social media environments. How does news sharing change the gatekeeping preferences of news organizations? Will polarized users polarize news organizations further? In this article, we model news sharing behavior in social media and derive implications for the study of gatekeeping in political communication. We model users' news sharing behavior using observational data from Twitter and then use the parameters from our model to explain its effect on editorial gatekeeping. The article provides a road map for researchers interested in the relationship between these major theories in political communication. We test our model using Twitter data collected during the election of populist leader Jair Bolsonaro in Brazil.

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Introduction

In today's social media environment, the activation and propagation of content requires users to share posts published by their peers. A substantive fraction of these social media posts include hyperlinks to content created by news organizations. As users share these posts, they make content available to a wider readership. News organizations, therefore, are now more attentive to the preferences of users, with journalists and editors being rewarded for solid digital metrics that report on a job well done (Belair-Gagnon et al., 2020; Blanchett Neheli, 2018; Tandoc, 2014; Vu, 2014).

The increasing importance of news sharing, and its effect on the routines, practices, and values described by the hierarchy of influences model, raises new questions about content creation in polarized social media environments (Shoemaker and Reese, 2013; Shoemaker and Vos, 2009). As noted by Tandoc (2014), if media organizations seek to increase readership and if readership increases with news sharing, the preferences of users will affect the organizations' editorial choices. Thereby, there is a clear causal chain that connects current theories of *news sharing* (Kümpel et al., 2015; Bright, 2016) with theories of *gatekeeping* (Shoemaker et al., 2017; Shoemaker and Vos, 2009). As described by Shoemaker et al. (2001), "gatekeeping is the process by which the vast array of potential news messages are winnowed, shaped, and prodded into those few that are actually transmitted by the news media."(Shoemaker et al., 2001, p.233). With the advent of online news sharing, the question of how users influence gatekeeping has become particularly relevant.

News sharing by users (the audience) has become more salient in shaping journalistic routine practices (Blanchett Neheli, 2018; Zamith, 2018), in the promotion of news content (Russell, 2019), as a mechanism of reciprocal influence among journalists (Hanusch and Nölleke, 2019),

and as an important source for journalistic content (Von Nordheim et al., 2018). Consequently, among other professional considerations, editors are increasingly reporting news sharing and digital metrics that report on users' behavior as relevant in making editorial decisions. In this article, we treat the question of news sharing as an empirical problem and describe its expected effect on gatekeeping when organizations with different reputations factor into the editorial decisions of the preferences of the public.

The integration of *news sharing* and *gatekeeping* is a required step to answer two important questions: Will news organizations create content that caters to extreme users in distinct social media communities? And, if they do so, will a polarized readership polarize news organizations even further? In this article, we provide a qualified affirmative response to both questions. Our theory describes mechanisms that explain how news sharing interacts with polarization, explaining editorial drift to more extreme positions. A silver lining of our results, however, is that media reputation reduces the organization's sensitivity to polarization. Therefore, while users' polarization should increase media polarization, it will do so more readily when media reputation declines.[1]

Our theory extends current voting models from political science literature to describe the effect of news sharing behavior on the gatekeeping routines of news organizations. As described by Lu et al. (2020), we understand that different metrics are not equally likely to override or to accommodate existing news values and journalistic routines in today's media environment. Once metrics are selected, however, users that activate news content by sharing media posts (Aruguete, 2019; Meraz and Papacharissi, 2013) should affect journalistic routines (Tandoc, 2014). Our research clarifies the relationship between users' demands and ideological drift in

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[1]Notice that in our model, readership influences on media biases are not deterministic but probabilistic. Increased news sharing by ideological readers, in our model, provides an incentive to better accommodate those preferences. The empirical exercise of determining the nature of the users' demand and the benefits for news organization is what our model seeks to clarify.

gatekeeping behavior if media organizations seek to benefit from news sharing.

We proceed as follows: using observational social media data as input, we first model the decision to share news conditional on the (1) user's *cognitive congruence* or *dissonance* with the ideological leaning of posts; (2) the overall reputation of a news organization (*prevalence*); and (3) the *attention* of users to different issues. In the Supplemental Information File (SIF) to this article, we provide further details on how all three measures (ideology, reputation, and attention) can be derived from observational data. We then use these *news sharing* parameters to compute an *optimal* editorial line of media organizations.[2]

The corollary to our analyses is that, conditional on existing journalistic practices and even if editors seek to maximize readership, not all news organizations will polarize equally and abandon their editorial ethical considerations. High-reputation outlets will be less sensitive to intense ideologues and take on more moderate gatekeeping positions. Smaller and less reputable outlets, on the other hand, will be crowded out to more extreme editorial positions, publishing content that better aligns with in-group users. Moderation by high-reputation organizations and extremism by low-reputation ones, we show, are optimal strategies when users are polarized.

A different interpretation of the same results is that the readership penalties for publishing centrist articles is consistently higher for smaller outlets. Therefore, as news sharing signals become stronger, less reputable outlets increase readership by taking more extreme positions, while high-reputation outlets increase readership when delivering content that is ideologically moderate.[3]

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[2]The precise definition of *optimal* in our article is the *ideological leaning of content which maximizes overall news sharing for an organization.* Therefore, optimal does not mean that is normatively preferred by the editors but that it ensures the largest content exposure for the media outlet.

[3]The comparative statics of moderation ("higher content exposure today") is separate from the potential future gains from maintaining a high-reputation stock ("moderation to increase reputation"). Following insights from one of the anonymous reviewers to this article, the concluding remarks discuss extensions to our model if and when *future gains* from reputation are considered. The basic model introduced in the article, however, formalizes the moderating effects of *current* rather than *future* reputation gains.

We assess the empirical implications of our model using news embeds in Twitter posts. We analyze 2,943,993 tweets published by 162,107 high activity accounts during the election of Jair Bolsonaro in Brazil, collected from September 26 through October 2 of 2018. Today, politics in Brazil is highly polarized, with social media featuring prominently in current electoral debates. Brazil also displays high rates of Twitter usage, ranking 5th in total number of twitter accounts.[4] As in other countries that in recent years elected far-right populist leaders, Bolsonaro built a faithful following on social media. The election of Bolsonaro provides a perfect case to study news sharing in polarized media environments.

Literature Review: Sharing news in polarized environments

In the last fifteen years, news sharing in social media has gained increasing attention (Kümpel et al., 2015). News sharing has upended previous notions of gatekeeping, raising questions about the editors' incentives to exercise editorial discretion (Shoemaker et al., 2017). It has also challenged existing models of journalistic practice, with revealed consumption by users altering perceived journalistic reputation, attention to issues, and the financial bottom line of media organizations. From "networked journalism" (Jarvis, 2006) to "networked public sphere" (Reese and Shoemaker, 2016), new theoretical efforts have sought to clarify the relationship between users' preferences and journalistic practices.

The effect of news sharing on gatekeeping has become all the more relevant with the advent of social media, with motivated reasoning and cognitive congruence featuring prominently in the decision to activate content among interconnected peers. While there is mixed evidence to support the existence of *true* social media bubbles, wherein audiences are exposed to a

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[4]https://www.statista.com/statistics/242606/number-of-active-twitter-users-in-selected-countries/

narrow subset of news contents, there is extensive documentation that cascading activation on political issues induce distinct local frames (Aruguete and Calvo, 2018). One of the strongest indictments against social media bubbles by Barberá et al. (2015) shows that the same users that are polarized on political issues also exchange information with each other on non-political issues. However, while the authors argue that network connectivity is less important than motivated reasoning,[5] the authors document that political content aligns with the preferences of the different communities. As in Aruguete and Calvo (2018), our model only requires the assumption that users in each community are more likely to activate content that is cognitively congruent with their preference. The cascading activation of distinct political frames will then create incentives to accommodate the preferences of those audiences.

Recent research by Zamith (2018) places the effects of *quantified audiences* on journalistic practices in the context of a long scholarly tradition where "interpretations emerge in the minds of newsworkers through exposure to different inputs over the course of day-to-day activity" (Zamith, 2018, p.419). Images of a constructed audience may, consciously or unconsciously, affect journalistic practices that define what is newsworthy as well as how it will be framed.

In related work, Belair-Gagnon et al. (2020) has highlighted how tensions between journalistic news values and audience metrics alter the role orientations, practices, and routines, of newsworkers. Just as in Hanusch and Tandoc Jr (2019), the discussion has moved beyond the question of whether audience metrics affect journalistic practices to the more important question of to what extent. Indeed, if "[t]he roles journalists conceive of are shaped, in part, by what they think audiences expect from them. Such expectations are now communicated to journalists routinely and easily through new audience feedback mechanisms: reader comments, social

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[5]See Lodge and Taber (2013) for an extensive discussion on the relationship between motivated reasoning and the consumption of political information.

media, and web analytics" (Hanusch and Tandoc Jr, 2019). While there is considerable focuses on the effect of audiences on journalistic practices, there is less research that analyzes the effect of polarized audiences on the editorial decisions of journalists. If, however, as Hanusch and Tandoc Jr (2019) note, views of the audiences shape how journalists conceive their own professional practice, it is important to model the effect of ideological audiences on editorial decisions.

Gatekeeping for the Choir

As political polarization increases, scholars have come to expect changes in the gatekeeping roles of editors and journalists who factor into their coverage decisions on the news sharing behavior of audiences and the potential costs and benefits to their organizations. Quantified audiences, we noted earlier, exacerbate the difficulties of balancing the preferences of end users and the editorial decisions of news organizations, as consumption and sharing validate (or not) the performance of their journalists.

Consider the problem as seen from the editor of a major news organization, who publishes a variety of news articles on wedge political issues (Hillygus and Shields, 2008). Being branded as pro- or anti-government (i.e. Bolsonaro, Trump, Johnson, etc.) will affect news sharing and circulation among misaligned audiences. Not catering to the preference of either community, however, will result in significantly lower content circulation, as intense ideologues who are very active in sharing news in social media will also be less likely to share news that does not align with their beliefs. What should be the optimal editorial line of the newspaper in such a polarized social media environment? Should editors emphasize frames by one of the opposing communities at the expense of circulation in the other? Should journalists discount the issues both communities want to read about? Should they factor in evidence and arguments that increase circulation by intense readers? What would be the effect of favoring circulation over

journalistic discretion?

If news sharing is important for the success of media organizations, researchers need to account for the heightened pressure of preaching to one of the choirs as well as for the effect of *quantified audiences* on circulation. Editors also need to consider the costs of not being shared by moderates today as well as the future reputation costs for their organizations. To explore the trade offs between circulation and moderation in polarized environments, we introduce readers to a model that uses observed sharing behavior to describe the effect of news sharing on gatekeeping. We begin by describing news sharing in the presence of polarized audiences and, then, derive an optimal gatekeeping response by editors. Finally, we evaluate the effect of polarization on position taking by media organizations in the case of President-elect Jair Bolsonaro. The results of our analyses summarize the trade offs that emerge in the gatekeeping decisions of editors when news sharing increases in importance and audiences are polarized.

A News Sharing Model

Our stylized model of news sharing begins by considering two types of actors, users $i \in I$ and organizations $j \in J$. Users share news that they care about (attention) and news that they agree with (cognitive congruence). Therefore, we expect that users will be less likely to share news that are cognitively dissonant and news on topics they are less vested in. Publications that are cognitively removed from the user will be less likely to be shared, both because users doubt their validity and because users are reluctant to communicate a dissenting opinion to peers (Lodge and Taber, 2013; Aruguete and Calvo, 2018; Bright, 2016).

While users favor content that agrees with their beliefs and they care about, they also perceive a higher utility from sharing news published by a reputable outlet. That is, users attach value

to the content because it is "credible," where "credible" describes content published by news organizations that a larger set of readers considers of higher quality (e.g., more investment, more infrastructure, longer time since the creation of the organization, etc.).

Therefore, users consider cognitive congruence, attention, and reputation, as distinctive features that provide value when sharing news to their network of peers. For the technical readers, a formal presentation of these parameters is summarized in greater detail in Appendix A of the Supplemental Information File (SIF).

Polarization: competing frames and competing audiences

We define polarization as a bi-modal distribution of social media users that give disproportionate importance to cognitive congruence when sharing news. For audiences on the left and right of the political spectrum, cognitive congruence weighs more heavily in their news sharing decisions. Therefore, we take as an empirical feature of social media data, that can be empirically tested, that users in each community differ on news they "like"; the extent to which they find news organizations "credible"; and the extent to which they pay "attention" to issues being reported. Each of these different parameters (ideology, attention, and reputation) can be estimated from observational data, per Appendix A in the SIF file.

In line with Hanusch and Tandoc Jr (2019) and Zamith (2018), the importance of ideology, attention, and reputation is observable to the editors through audience metrics. Editors can discern the extent of news sharing by users "on the left or right" of the political spectrum. They also know that sharing varies as a function of the issues being covered, the framing of those issues, and the reputation of the media organization. Therefore, audiences influence what is covered (Russell, 2019), what constitutes an important source of journalistic content (Von Nordheim et al., 2018), and the metrics that should factor in gatekeeping (editorial decisions) (Hanusch

and Nölleke, 2019). If this is true, then audience polarization will increase media polarization.

Retrieving preferences from observational data

The previous model description gives an equation where user i's utility from sharing news on issue k by organization j is:

$$U_{(ij)}^k = -\alpha_{q(i)}^k \left(x_i^k - L_j^k \right)^2 + A_{q(i)}^k + R_{q(i),j}^k + \gamma_{ij}^k \tag{1}$$

In Equation (1), the quadratic term $\alpha_{q(i)} \left(x_i - L_j \right)^2$, describes the disutility of a post that is further removed from the reader's preferred ideological position, x_i. For every unit of increase in cognitive dissonance, the utility of reader i declines by α_q, which is negative because it describes the disuitility of the user. The parameter α also has a natural interpretation as the weight that a reader attaches to the ideological leaning of a media organization. For a Brazilian reader, for example, ideology will be less important on soccer coverage than when browsing news on President Bolsonaro.

Equation (1) also indexes the parameter α by q, allowing cognitive congruence to have a heterogeneous impact in different regions of the social media network. In our empirical application, we create q bins by splitting the network into one hundred equally sized squares, capturing two-dimension deciles of the network layout. That is, we allow cognitive dissonance to vary according to where in the network the user is.

Equation (1) also shows that news published by a more reputable actor, $R_{q(i),j}^k$, increases the utility of reader i. Reputation also varies by the location of users in different regions of a network.[6] Finally, users may also give different attention to an issue, $A_{q(i),j}$, sharing a higher

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[6]The empirical model presented in the following sections assumes reputation varies only by media, simplifying the estimation for each user.

than average number of posts with social media peers. Equation (1) also includes a stochastic term that captures overdispersion, γ_{ij}^k, by user and media outlet.

The choice function for equation (1) describing the likelihood of clicking a particular news link produced by media j out all organizations is described in Equation (2):

$$S_{ij}^k = \tau_i \frac{e^{U_{ij}^k}}{\sum_{j=1}^J e^{U_{ij}^k}} \ \forall \ i, j, k \tag{2}$$

In equation 2, the total number of news that is shared is a function of the probability that users will select a post by agent j in the decile q, subject to the users' attention constraints, τ_i, which describes the total number of times a user will share news. Some readers may share a large set of news while others may do so sporadically. The SIF file provides estimation details to retrieve these parameters from a matrix of news embeds in observational data.

A Gatekeeping model: The editor's decision

In the previous section we describe a news sharing model where users activate content on issues they care about (attention). They are also more likely to share content that is cognitively congruent (ideology) and that was produced by more reputable media organizations. We now focus on the editor's optimal editorial decision (Gatekeeping), which is a maximization problem that considers the revealed preferences of users as well as the editorial decision by other news media organizations.

Our objective in modeling the editorial response is to understand to what extent news organizations are likely to be sensitive to a polarization of the audiences. Therefore, solving this model is not a trivial exercise but rather one we believe has important theoretical implications. In particular, the comparative statics of the model show how reputation and ideology interact

in polarized political environments.

Adams et al. (2005) provide an algorithm to solve this problem. Extensive discussion about the algorithm can be found in [omitted authors]. We provide a streamlined description, with numerical optimization taking as input the parameter estimates of equations (1) and (2), used iteratively to find the optimal ideological leaning of an editorialized news item, L_j^{k*}.

We follow Adams et al. (2005) and iteratively solve for the target audience whose ideological preferences will maximize overall news sharing by a media organization, conditional on the ideology, reputation, and attention parameters from all social media users. More technically, the algorithm maximizes the expected market share of each news organization conditional on the vector of equilibrium news locations L and the the three behavioral parameters $\widetilde{\alpha_{q(i)}}, \widetilde{A_{q(i)}}, \widetilde{R_{q(i),j}}$, $\sum_j \pi_{ij}(\mathbb{L}|\widetilde{\alpha_{q(i)}}, \widetilde{A_{q(i)}}, \widetilde{R_{q(i),j}})$. Adams et al. (2005) differentiate equation (3), solving for the last occurrence of $\mathbb{L}$:

$$\mathbb{L}_j(0) = \frac{\sum_j \pi_{ij}(\mathbb{L}, 0)[1 - \pi_{ij}(\mathbb{L}, 0)]x_i}{\sum_j \pi_{ij}(\mathbb{L}, 0)[1 - \pi_{ij}(\mathbb{L}, 0)]} \tag{3}$$

The model then iterates over each news organization until convergence is achieved. Following Calvo and Hellwig (2011), we estimate the comparative statistics of the model through simulation, mapping the effect of three parameters of interest over approximately two million solutions to the different combinations.[7]

Gatekeeping: Interpreting the results of the model

After running equilibrium models for all parameter permutations, we post-process the data to assess the effect of users' preferences on the optimal ideological content published by media

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[7]See the appendix for a full explanation of the values employed in the simulations and for a more exhaustive discussion of the comparative statics of the model.

organizations. We then compare how organizations react under two different distributions of the users' preferences. We consider both a normal distribution (non-polarized media market) and a bimodal distribution (polarized media market). Most applications of Adams et al. (2005) consider a voting population with preferences normally distributed.[8] As we will show, in polarized political environments there is a stronger centrifugal effect that pushes high-reputation organizations to the region that falls between the overall median voter and the high-density regions on the left and right.

The effect of cognitive congruence on media polarization

Let us begin by holding the importance that readers attach to ideology and reputation to their median levels, $\alpha = -0.06$ and $\beta = 0.6$. We also allow the $cov(\alpha, \beta) > 0$ to be strictly positive, with readers on the left having higher assessments of reputation for Media A and B, while readers on the right have higher assessments of reputation for Media D and E. We also set reputation values for all organizations to be identical, $R_1 = R_2 = ... = R_5$.

Figure 1 provides visual representation of the effect of user polarization on social media polarization. Each plot describes the ideological position of media organizations on the horizontal axis and the corresponding share of users (market share) on the vertical axis. In equilibrium, all news organizations produce moderate content in a non-polarized environment (right plot) while news organizations spread in the ideological space in polarized environments. The direction of ideological change for each media is driven by the relationship between perceived reputation and ideological preferences for distinct groups of voters, $cov(\alpha, \beta) > 0$. However, the same underlying $cov(\alpha, \beta) > 0$ has little effect in non-polarized environments.

Given that readers with different ideological leanings have heterogeneous assessments of each

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[8]We combine two normal distributions, mean-centered on the left, 2.5, and the right, 7.5, of the political spectrum.

media's reputation, changes in the distribution of the readers' preferences yield changes in the optimal editorial line of media organizations. The left plot shows how polarization among readers pulls media organizations away from the center of the distribution. When the social media environment is not polarized, by contrast, the centrifugal effects on the optimal editorial strategic positioning is weaker.
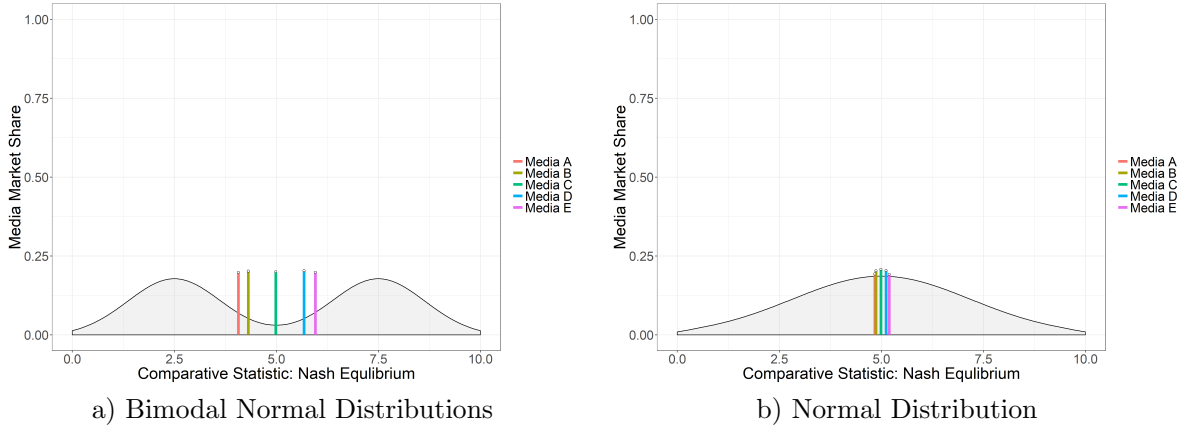

a) Bimodal Normal Distributions   b) Normal Distribution

Figure 1 Comparative Statistics: Impacts of readers' ideological polarization

Consider now the situation in which readers increase the weight or importance of ideological concerns when sharing news content. Figure 2 presents the optimal gatekeeping strategy for media organizations, holding all parameters to their median values except for the weight of ideology ($alpha$), which is increased from -.06 to -.12. The optimal gatekeeping strategy is for media organizations to cater more clearly to ideologues in each community, moving away from the global median voter to the inner hillside of each mode and closer to the leftist or rightist median voter. That is, they move away from the moderate voters and towards the local median user in the left and right of the political spectrum. Notice that more ideological readers does not mean more extreme readers but, instead, that readers care more about cognitive dissonance when activating content. Moderate readers may drastically reduce information that is cognitive dissonant. In fact, the underlying distribution of readers has not changed in this example, but

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only the intensity of readers' ideological considerations on issue k.

Larger negative values of *alpha* indicate a sharp decline in the activation of content as the post moves away from a reader. Consequently, in more ideological environments (right plot), media organizations move to the median voter on the left and right of the political spectrum as ideology (cognitive congruence) weighs more heavily on the decision of readers to activate content. In conclusion, as ideological attachments increase, the overall median user thins out.

a) $\alpha = -.06$ b) $\alpha = -.12$
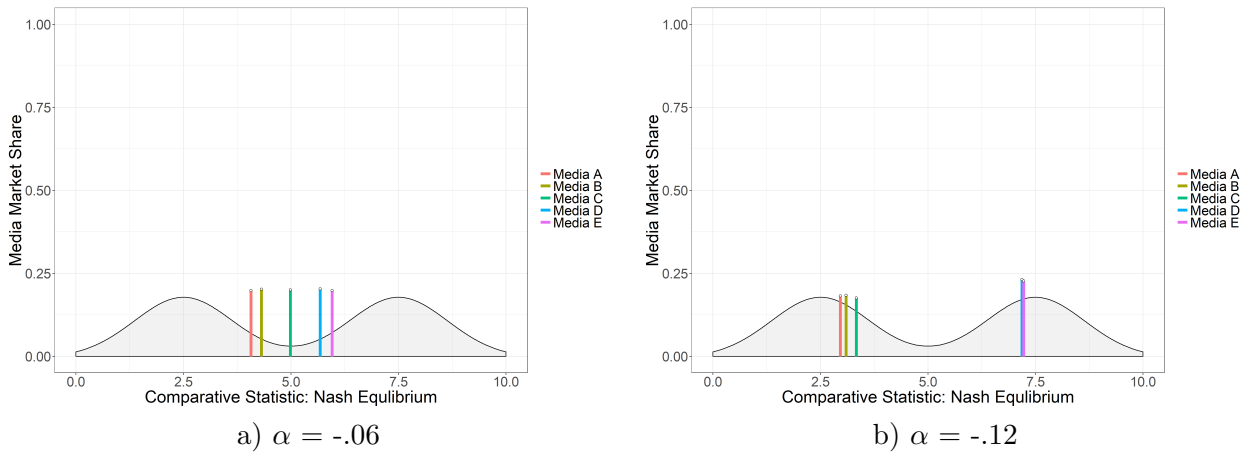
Figure 2 Comparative Statistics: Effect of the weight of ideology, α, on the media's equilibrium positions

Increased salience on issues that weigh heavily on ideological considerations, therefore, will more forcefully pull media away from centrist positions. When cognitive dissonance matters, media organizations will be more likely to accommodate the ideological preferences of said readers, that is, to the ideologues that already give them high reputation marks for the news they deliver.

Therefore, our first hypothesis:

H1: Greater weight of users' ideological considerations will correlate with media organizations advertising more extreme ideological positions.

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The effect of reputation on media polarization

In the previous example, the mean reputation score across media organizations was identical. That is, each of the media organizations was perceived as equally "capable" by users. Therefore, only the weight that readers attached to ideological congruence or dissonance mattered. However, both on the left and right of the political spectrum, there are news organizations that are perceived as having a higher or lower reputation than their competitors. Indeed, a key feature of our model is that the users' assessment of media reputation varies among news outlets and has a positive effect on news sharing. Our second hypothesis evaluates the effect of such reputation on the optimal editorial decision of news organizations.

What is the effect of having news organizations that have different "reputation" values? The comparative statics show that organizations with a higher overall reputation (e.g., the average reputation of Media A for all readers is higher than the reputation of Media B for all readers) will take more moderate ideological positions. Meanwhile, news organizations with comparatively lower reputations will be crowded out to more extreme locations.

Figure 3 presents the equilibrium location of media organizations under *parity* and *asymmetric* reputation. In the asymmetric reputation context, Media A and Media E are recognized as having higher overall quality (Reputation) than media outlets B, C, and D. Notice that Media A and Media E also had more ideologically extreme readers which resulted in those media organizations being further to the left and right when all organizations have equal reputation. The comparative statics of the model provide clear evidence of a centripetal shift by high-quality outlets. In the reputation symmetry case, the left plot on figure 3, all the outlets have equal reputation, and they are distributed from left to right as a linear function of $cov(\alpha, \beta) > 0$.

On the other hand, higher reputation yields a wider readership when catering to moderate

users. High-reputation organizations can take advantage of their reputation surplus, moving further away from their natural readership (readers with higher assessments of the reputation for that media) towards the overall median reader. The result is that a better reputation leads to moderation.

Smaller outlets, by contrast, are crowded out to niche audiences, most of which are on the ideological extremes. As media outlets with low reputation see a sharp decline in readership when they move away from their core readership, they are held fast in their tracks to intense users that attach a high premium to ideology.
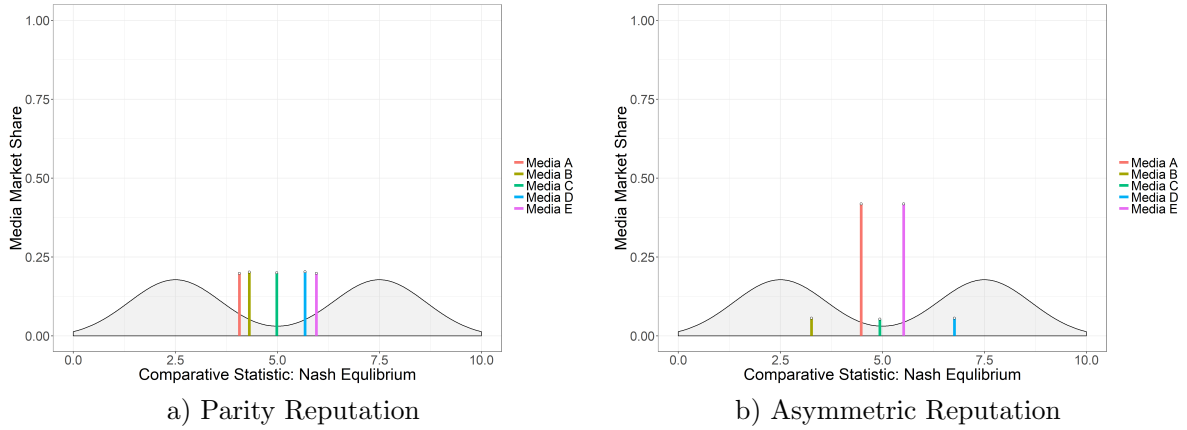

a) Parity Reputation   b) Asymmetric Reputation

Figure 3 Comparative Statistics: Impacts of Asymmetric Reputation

Therefore our second set of hypotheses:

H2a: When reputation is asymmetric, organizations with a reputation advantage take on more central or moderate ideological positions.

H2b: When reputation is asymmetric, organizations with a reputation disadvantage take on more extreme or fringe ideological positions.

In the next section, we empirically assess the model using observational data from Twitter from the #Bolsonaro election in Brazil. We examine the rate at which users embed links to different media organizations and estimate the ideological weight and reputation parameters

that explain the centripetal or centrifugal placement of media organizations. We present some descriptive information of the network and different patterns of activation across the polarized communities in #Bolsonaro. Finally, we describe how more reputable media occupies the center of the network and are less dependent on ideological proximity to activate their readers.

Embedded links in the Bolsonaro election

Jair Bolsonaro, a captain in the Brazilian Army, won his first election as a local councilor for the city of Rio de Janeiro in 1988, just two years after Brazil emerged from two decades of brutal dictatorial rule. An op-ed in the prestigious Brazilian Magazine *Veja* launched the political career of Jair Bolsonaro when he demanded higher wages for members of the military while Brazil was democratizing. Four years later, in 1990, the former captain won a seat in the Brazilian House, a post to which he would be reelected six times. In 2018, in the context of profound economic crises and intense ideological polarization, Bolsonaro won the presidential race.

As in other countries that in recent years elected far-right populist leaders, Bolsonaro relied heavily on social media during his campaign. Much of the social media effort of Bolsonaro relied on relatively new news outlets that lack the funding, staff, and reputation that characterize Brazil's traditional media (Teixeira et al., 2019). These news organizations competed for the attention of users with Bolsonaro's direct and personal relationship with the far-right which was amplified by an emerging cast of new outlets.[9] The election of Bolsonaro provides a perfect case

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[9]Similar to Donald J. Trump, Jair Bolsonaro maintained a very active presence on Twitter and Facebook during his campaign. He also held public live online video calls and promoted personal videos on YouTube. His social media activity increased dramatically after a life-threatening attack early in the campaign, which restricted his public appearances. The Brazilian 2018 election was also flooded by false rumors, manipulated photos, decontextualized videos, and audio hoaxes in a variety of social media environments (Tardaguila et al., 2018). Much of the social media presence was carried out through recently created news outlets, part of a widespread *astroturfing* campaign that included hundreds of thousands of WhatsApp accounts.

to study news sharing in polarized media environments. How a fringe far-right underdog won the presidency of one of the world's leading economies will remain a salient research question for years. In this article, we focus on a narrow question about how users share campaign news in social media in such a polarized environment as well as the optimal response of the media organizations.

The Data

From September 26 through October 2 of 2018, we gathered 5,325,240 posts that included the characters *"Bolsonaro"* using Twitter's search API. We then created a network that included all retweets from the original data, with dyads of all *authorities* and *hubs*. We then thinned down the network, eliminating singletons by removing users that retweeted fewer than three times. Finally, we retained the largest connected cluster of the network, holding 196,066 high activity users who posted 2,943,993 tweets.

For descriptive purposes, we draw users' [x,y] coordinates implementing the Fruchterman-Reingold algorithm in igraph-R (Csardi et al., 2006). We then ran the walk.trap algorithm in *igraph* to identify the users' communities. The walk.trap algorithm identified two large communities aligned with the opposition (91,116 users) and the Bolsonaro campaign (62,289 users). The remaining 8,702 accounts were placed in smaller communities weakly connected to the core of the network.

Figure 4 lists the top authorities of the two largest communities. In the anti-Bolsonaro camp, eight of the top ten users had *verified* accounts that included well-known politicians, left-wing news organizations, and some more traditional media organizations, such as the magazine *Veja* (@VEJA) and the newspaper *Folha de Sao Paulo* (@folha). On the other side, only three of the top ten users in the Pro-Bolsonaro community had *verified* accounts. By contrast,
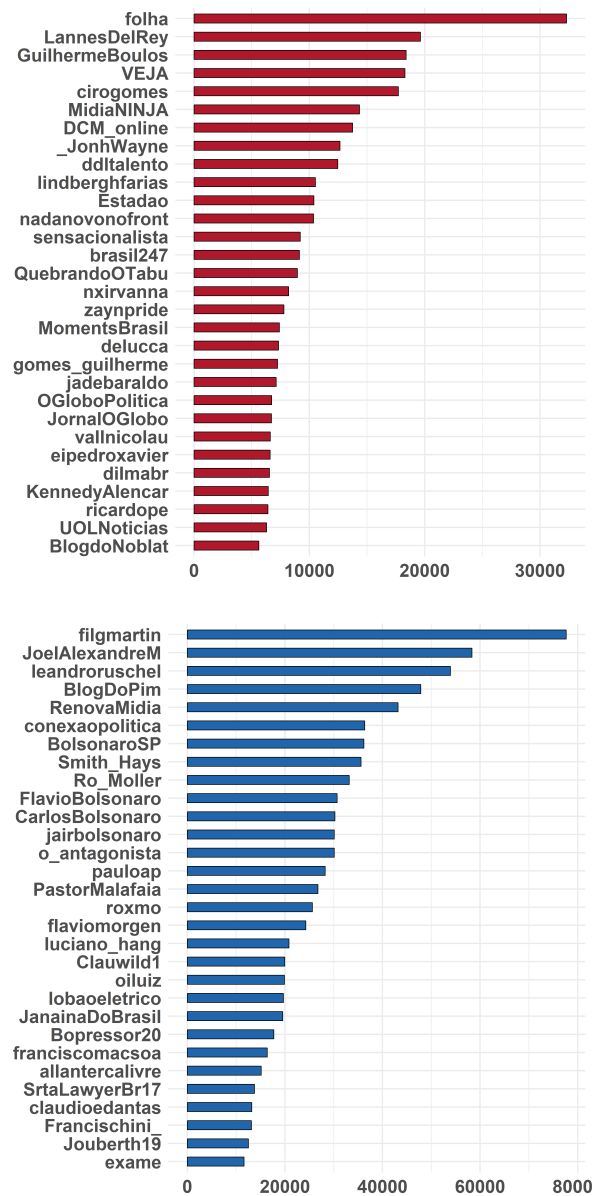
Figure 4 Authorities in the sub-networks aligned with the the Anti-Bolsonaro Communitiy (red) and the Pro-Bolsonaro users (blue)

fakes, *trolls*, and anonymous websites figured prominently in the pro-Bolsonaro community, such as @JoelAlexandreM, @conexaopolitica, @RenovaMidia. The comparison between the two communities is striking. While well-known and highly visible politicians and journalists led the anti-Bolsonaro effort, the pro-Bolsonaro campaign on Twitter was driven by anonymous political operatives and relatively new media organizations.[10]

Figure 5 describes the full #Bolsonaro network, with users aligned with the president-elect in blue circles, users aligned with the Anti-Bolsonaro users in red diamonds, and the rest of the users in beige and light gray dots. The size of the nodes describes the in-degree of each user, with larger nodes indicating accounts that were re-tweeted more often. The community of the opposition is 30% larger than that of Bolsonaro's supporters.

Out of the 5,325,240 tweets in the #Bolsonaro network, slightly over 15.3% included hyperlinks to content already published online, $816,694/5,325,240 = .1534$. Links to the top 24 media outlets represented 78% of all hyperlinks, 640,595/816,694, with almost a third of them connecting to existing Twitter posts and the other two-thirds directing readers to news organizations. While only 15% of tweets included hyperlinks to other media, it is worth noting that 97,160 accounts out of the 196,066 tweeted or re-tweeted content with hyperlinks to news organizations. Therefore, over 45% of the users activated news content from other sources.

Descriptive Information on News Sharing in the *Bolsonaro*

Visual inspection of Figure 6 shows that media organizations were activated to a different extent by Pro-Bolsonaro (blue) and opposition users (red). Each plot in Figure 6 describes the

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[10]Indeed, a front-page report from Folha de Sao Paulo on 18 October, 2018 described financial support for Bolsonaro that illegally bankrolled WhatsApp and YouTube fake news operations. This includes an intense campaign against Bolsonaro's front-runner opponent, Fernando Haddad. Significant research, in consequence, has been directed to explain the spread of false information by the Bolsonaro campaign. Considerably less research, however, has analyzed how traditional media outlets positioned themselves during the campaign.
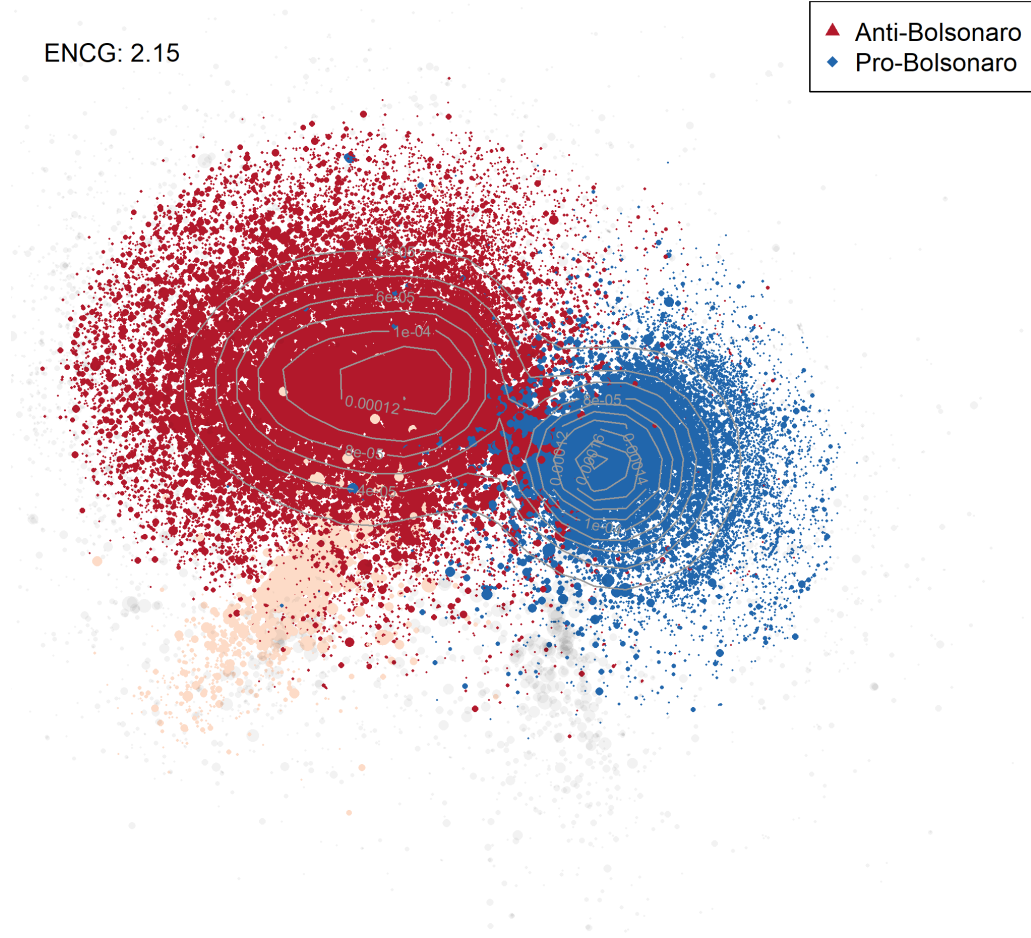
Figure 5 Primary Connected Network of #Bolsonaro. Blue dots describe users aligned with the Bolsonaro. Red dots describe users aligned with the opposition. Layout of users estimated using the Fruterman-Reingold algorithm in *IGraph*. Community detection using Walktrap algorithm in *IGraph*, (Csardi et al., 2006)

region of activation of a different media outlet, measured by the number of times that users

posted or retweeted content from each media source. Wider plots indicate that a larger set of

users activated that content. For example, the upper left plot in Figure 1a shows that textitFolha

was shared by a sizable number of users in both the pro- and anti-Bolsonaro communities. Plots show significant variation in activation, with some news organizations such as the *Folha de Sao Paulo*, *Veja*, *Estadao*, and *Globo*, all shared widely while others were narrowly linked by one of them, as was the case for *O Antagonista*, *Brasil247*, *Gazeta do Povo* and *Conexao Politica*.

There are some insightful considerations about the activation maps provided in Figure 6. First, as expected, larger outlets are more broadly shared by both communities. Second, the figure gives a clear picture of the polarized environment of the Brazilian election. Beyond the more reputable outlets, most other sources of news, such as *O Antagonista*, *Brasil 247*, and *O Sensacionalista*, are shared exclusively by one of the communities with very little cross-community exchange of embedded links.

In addition, one of the differences between both communities is precisely the degree to which Pro-Bolsonaro users embed links from anonymous political operatives online. *Conexao Politica*, *Tribuna do Ceara*, *Republica de Curitiba*, and *Jornal Cidade Online* are all examples of unknown websites who worked as ammunition for Bolsonaro's campaign strategy of propagating fake news and aggressive online discourse. We do not observe these operatives with the same centrality in the opposition network of embedded links. In the latter group, the propagation of news comes mostly from left-wing journals and websites, which are not anonymous sources, and also from more reputable, well-known outlets.

The activation maps provided so far do not allow us to precisely discriminate how much news sharing is explained by cognitive congruence/dissonance, the media's reputation, or the user's attention to the issue. In the following section, we estimate our complete theoretical model, from equation (1), for news sharing and gatekeeping behavior of media outlets.
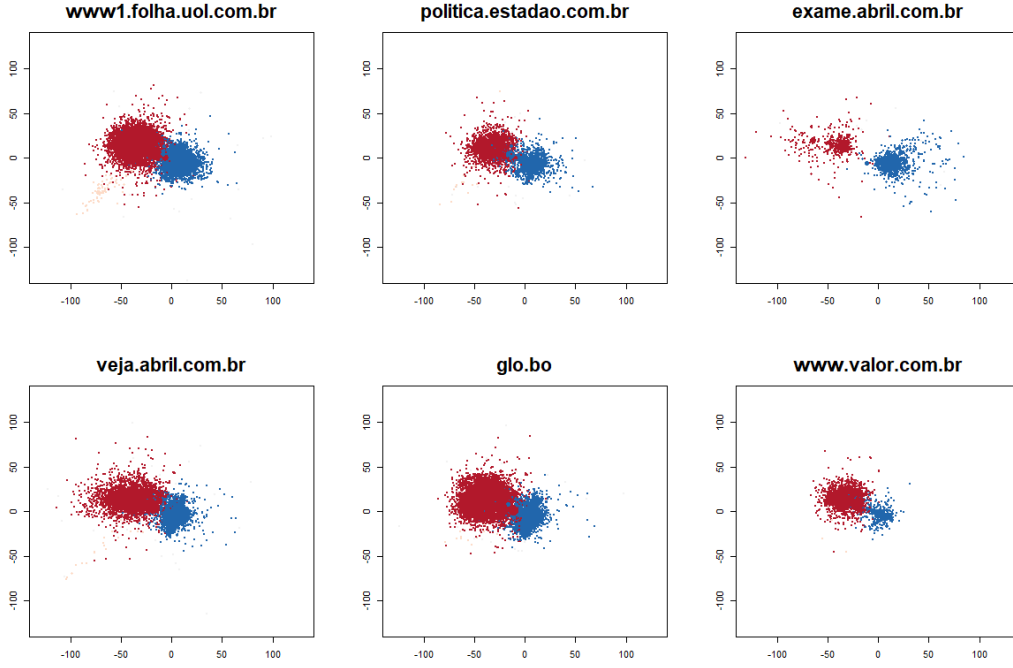
(a) More Reputable News Organizations
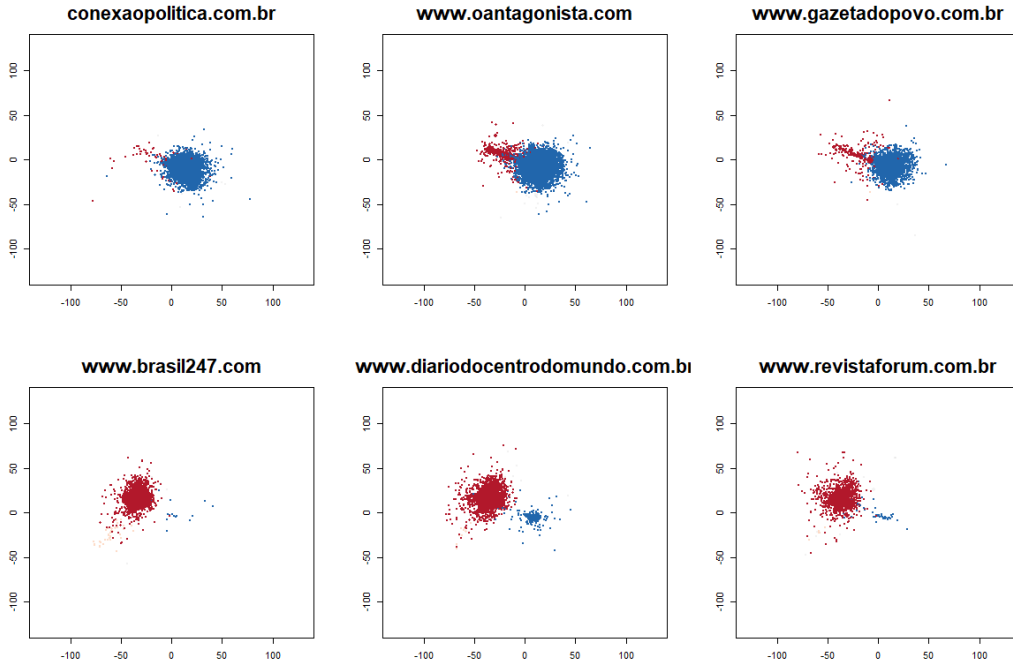
(b) Less Reputable News Organizations

Figure 6 Embedded news in the Primary Connected Network of #Bolsonaro. Blue dots describe Pro-Bolsonaro users. Red dots depict Anti-Bolsonaro accounts. Figures describe the activation of hyperlinks to published news by both communities.

News sharing and gatekeeping in #Bolsonaro

We model the utility function from equation (1) using a multilevel specification. We use a random slope, α, and two random intercepts, A and R, where α captures the weight that readers attach to ideological congruence, and A and R describe the importance of user attention and reputation of the outlet in the #Bolsonaro network. We focus our discussion here on the importance of ideology and reputation to explain news sharing by the users and the gatekeeping decision by editors. We estimate a generalized linear binomial count model using a logistic transformation with an overdispersion parameter for user and media outlets, as suggested in Zheng et al. (2006).

Given that the highest density point of each media organization $\mathbb{L}_j$ is unobserved, we need some approximation to calculate the parameter α. We approximate the location $\mathbb{L}_j$ by deriving a weighted average of each user i location using the first dimension of the network by the number of links embedded from each organization j. After estimating these points, we calculate the distance between the user location and the highest density point of each media outlet in the network. We model the parameters for cognitive congruence/dissonance by deciles across the network. The motivation for binning the network by quantiles is twofold: first, it makes the model computationally less intense,[11] and second, it provides us theoretically interesting parameters allowing for the identification of heterogeneous values for ideology in different parts of the #Bolsonaro network. In the appendix, we provide the results for a simpler model estimating the effects of cognitive congruence using the two dimensions of the network and binning the estimation by quantiles on both directions.

Figure 7 presents estimates for the weight of cognitive congruence/dissonance (ideology) for

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[11]See here [ommitted authors] for a complete explanation of the computational gains of binning the network.

the users estimated by quantiles in the #Bolsonaro network. The plot indicates where proximity between the user and media outlet matters more/less, with larger negative values indicating more salience for ideology. In other words, the graph documents in which areas of the network the decay to embedding links from sources far away from the user position is greater. Figure 7 reveals two things. First, users in the extreme of the network weigh cognitive congruence heavily in their decision to share the news. This behavior appears in both pro- and anti-Bolsonaro communities with the 1st and 2nd and 9th and 10th quantiles exhibiting more negative values.

Second, the importance of ideological congruence in #Bolsonaro tends to decrease when moving to the center of the network. This finding relates to research using survey data (Calvo and Hellwig, 2011), and also replicates when analyzing different networks [ommitted authors]. The exception here locates at the 6th quantile, which represents precisely the division between both communities, as the reader can visualize on Figure 7. Users located in the crack of this polarized environment act as ideologically as those at the extremes, sharing news mostly from outlets located closer to them in the network. At the extremes, users interact with polarized outlets demanding news with highly congruent stories; in the crack of the polarization, users work to differentiate themselves in the polarized environment, therefore interacting with outlets ideologically distant to both sides of the polarization.

Next we turn to the estimates for reputation. Figure 8 presents the point estimates for each of the 24 outlets in the model. The results converge relatively well with our qualitative argument about the media market in Brazil. As we expected, larger outlets in Brazil such as *Folha de Sao Paulo*, *Abril*, *Globo*, and *Uol* depend less on congruence and dissonance of the ideological preferences from the users. The exception here is the website *O Antagonista* that appears as one of the outlets leading our estimation for reputation. This finding is driven by the high activation
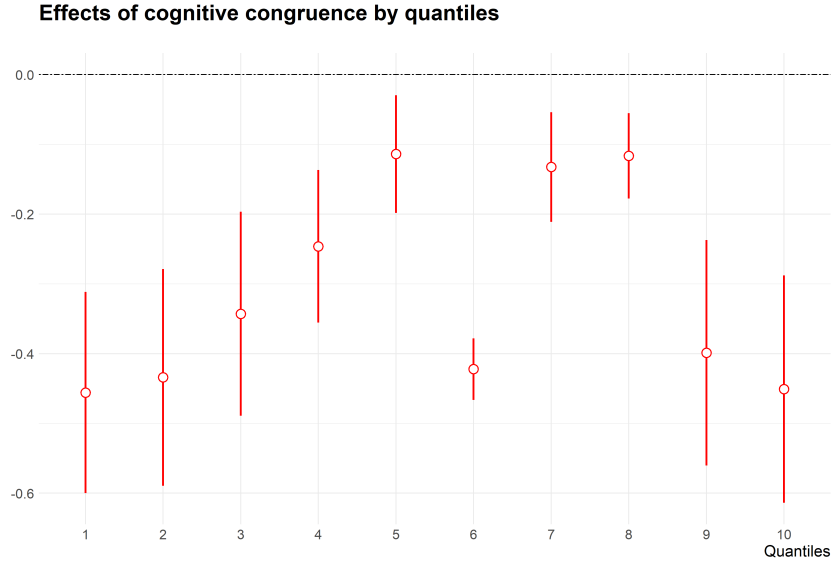
Effects of cognitive congruence by quantiles

Figure 7 Point estimates from the multilevel model for the effects of ideology for the users by quantiles in the #Bolsonaro network.

of *O Antagonista* in the community in support of Bolsonaro receiving high and equally shared attention on most of the space occupied by these users. Therefore, despite not figuring as a traditional outlet in Brazil, in the #Bolsonaro network, *O Antagonista* appears as the broadest source of news in one of the leading groups engaging in the debates in this network.

On the other side, smaller news organizations, such as *Jornal da Cidade Online* and *Republica de Curitiba*, two of the fake news operatives highly activated among Bolsonaro's supporters, are on the other extreme of the reputational scale, as well as *Revista Forum* and *Brasil247*. The results indicate that the latter outlets derive their attention mostly by users who care about congruent news and are activated in minimal areas of the network.

After estimating the parameters of the model, we can use them to find the optimal ideological placement of the media if they were only interested in maximizing readership (Adams et al., 2005). This exercise provides a comprehensive assessment, using observational data, of our theoretical predictions. We present the results using six cases of more/less reputable outlets.[12]

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[12]We relied on Google ranks for the websites together with our qualitative assessment of media market in Brazil
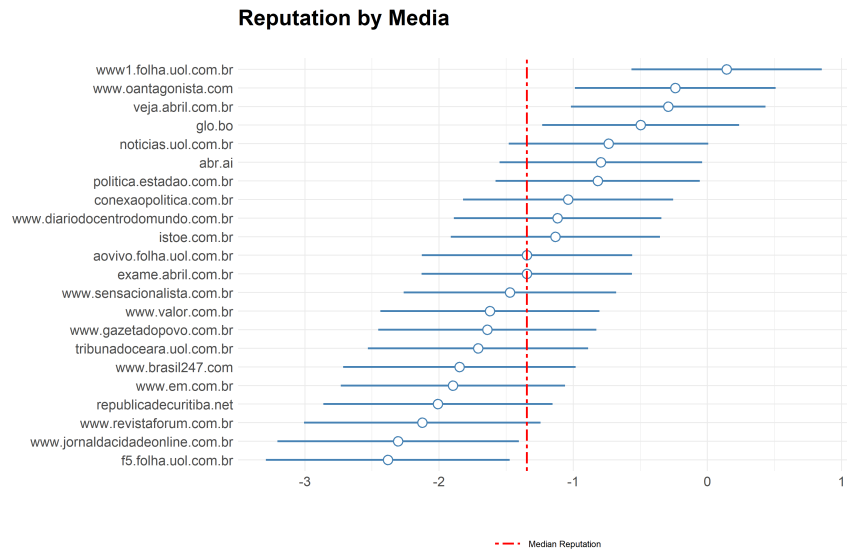
Reputation by Media

Figure 8 Point estimates from the multilevel model for the effects of reputation by media outlets in the #Bolsonaro network.

a) More reputable media
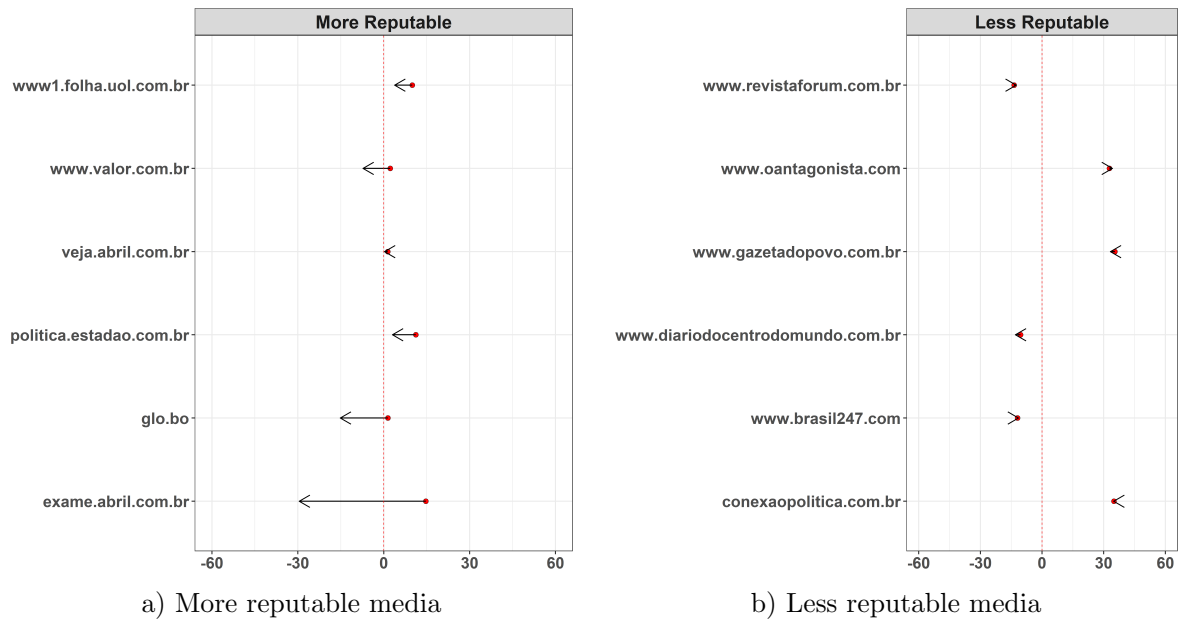
b) Less reputable media

Figure 9 Horizontal arrows describe the difference between the observed location and the optimal location of each news outlet. We derive the positions implementing Adams, Merrill, and Grofman's algorithm (2005) using Winbugs.

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Figure 9 documents three important findings. First, the outlets located farther away from the location of the median user in the network are mostly among those allied with Bolsonaro's community. The media outlets aligned with the opposition are, in fact, way closer to the center than their counterparts in the Bolsonaro community, suggesting radicalization on this issue is mostly driven by Bolsonaro's supporters. These findings converge with survey research and legislative data showing increasing levels of polarization among conservative users in the United States context (Bartels, 2008; McCarty et al., 2006; Mann and Ornstein, 2016; Theriault and Rohde, 2011).

Second, asymmetry in reputation correlates with distinct gatekeeping incentives by the editors, as our model predicts. All the outlets on the left of Figure 9 would receive greater attention from the user when moving to the center of the network, while the smaller and more ideologically committed outlets on the right are better of when appealing to users on the fringe. This finding goes in the direction of our hypothesis 2a and hypothesis 2b about the effects of asymmetric reputation.

Finally, Figure 9 also reveals how more reputable outlets have greater incentives to adjust their editorial lines, while less reputable outlets in this polarized environment are already sending messages highly congruent to their preferred user. As the reader can observe, the length of the arrows between the left and right plot differ consistently which indicates that smaller outlets are already located at their sweet-spot in this polarized #Bolsonaro network. High polarization, as it is in the case of the election in Brazil, increases high demand for congruent news, and asymmetric reputation produces incentives for smaller outlets to stay closer to the local median in this polarized network.

To ensure the robustness of our findings, we provide in the appendix further evidence connect-

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to subset the less/more reputable cases on figure 9. Results for all the cases are presented in the Appendix.

ing news sharing behavior and editors' gatekeeping decisions but implementing distinct modeling decisions. Using both dimensions of the #Bolsonaro network, we also show three findings. First, smaller outlets are crowded out to the fringe while larger news sources locate more to the center of the network. Second, the decay of activation moves at a faster pace for smaller outlets, which replicates the findings on Figure 9 indicating how less reputable outlets pay higher costs for moving and maximize their position attending high ideologically congruent users. Third, larger outlets have higher spread of activation across distinct areas of the network which we explain as a consequence of their reputational advantage.

Concluding Remarks

What explains news sharing in polarized social media environments? Will polarization of the audiences further polarize news organizations? In this paper, we develop a theory that connects existing theories of news sharing and gatekeeping to describe the conditions under which social media polarization will increase polarization among news organizations.

Our theory formalizes the expected effect of news sharing on gatekeeping, subject to differences in ideology and attention by users as well as differences in reputation among organizations. To test our argument, we provide a methodological innovation to estimate news sharing parameters from social media data.We present a mechanism that shows that polarization in social media will induce polarization among media organizations, conditional on their current reputation. We present formal results as well as empirical findings to support our contention that polarization will be highest among low-reputation news organizations. As reputation increases, news organizations converge towards the median voter. As reputation declines, news organizations cater to the local median voters in the different communities.

The results of our model have interesting implications for future research which, we think, are worth pursuing. For example, consider an external shock that reduces investment in the production of news, such that a media organization is perceived by readers as less reputable. The proposed mechanisms indicate that such external shocks will make ideological drift to more extreme positions more attractive. The opposite will be the case for a news organization that receives a large influx of money from investors, provided that the new resources do not have strings attached. As we calibrate the relationship between audiences and reputation, the proposed theory becomes more attractive as a tool to understand changes in the news media environment. While a fully dynamic model exceeds the objectives of this paper, relatively simple variations on the proposed model will accommodate a variety of interesting shocks that often affect news organizations.

Consider a different type of exogenous shock that, rather than affecting reputation, increases the attention of a subset of readers. For example, news about the NASCAR results raise considerable more interest among Republicans in the United States. However, the lack of cognitive dissonance among Democrats implies that there is no associated costs for all news outlets to report on this news. Because there is no cognitive dissonance, our model will show that news coverage would induce no ideological drift, in contrast with reporting on the decision of NASCAR to ban the Confederate flag. In other words, the proposed model can dynamically accommodate information shocks that would induce different types of news sharing incentives. Future extensions of the proposed model, therefore, would benefit existing research on gatekeeping behavior in the presence of different types of information shocks.

Our empirical results show how the communities involved in the presidential political debate in Brazil interacted with different online sources and how cognitive dissonance is higher on the

extremes of each community. Additionally, we document how larger outlets found their sweet spot in the center of an extremely polarized network, while smaller outlets extract larger gains catering to polarized users. For our empirical case, we document how the community of the supporters of President Bolsonaro interacted mostly with extremely ideological, online political operatives. These findings largely converge with our dynamic theory for sharing news and gatekeeping by media organizations.

Our results also speak to the central contemporary issue of polarization in the social media environment. We document how polarization, in particular, the portion driven by extremely ideological users in the fringe of both communities, produces centrifugal effects on editors' strategic positioning in this environment. Our findings provide a road map to understand how polarization in demand for content by social media users polarize media outlets with low reputation even further and reduce any incentive to moderation.

So far, our model describes media organizations that have no ideological preferences of their own. Many spatial models in political science take into consideration the policy preferences of politicians. In the communications literature, we need to consider both the existence of partisan media as well as the economic benefits of higher reputations, which increase the returns that media organizations perceive from vendors and donors. Future extensions of our model will incorporate discount functions for these economic considerations. It will also incorporate the potential benefits of endorsing politicians that could facilitate the expansion of an organization's income even at the expense of suboptimal editorial positions.

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News Sharing, Gatekeeping, and Polarization: A study of the #Bolsonaro Election

Supplemental Information File

Appendix A: Modeling news sharing behavior

In this section, we describe the estimation strategy to derive the three sets of parameters of interest summarized by our model: ideology, reputation, and issue attention. All estimates are derived from observational data, showing that not all users are equally likely to share information; not all media outlets are equally likely to be shared; and some users have clear preferences for some media outlets. Decomposing those three news sharing incentives provides significant insights into the complex phenomena of news sharing behavior in social media.

The statistical model implements Equation 1 from the main article, with a vector of social media users (rows) that share hyperlinks to media organizations (columns). The Table at the center of Figure A.1 provides an example with each user $u_i \in I$ sharing news published by media organizations, $m_j \in J$. For presentation purposes, let us assume that media organizations are listed from left to right by conservatism, so that m_1 is less conservative than m_2, and $m_1 < m_2 < ... < m_j$.

In Figure A.1 we see a higher number of embeds by user u_2, 25, and a lower number of embeds for media m_3 and m_j. Therefore, row means approximate, somewhat imprecisely for now, information on the overall attention users give to news hyperlinks on a given topic. Mean embeds by columns, on the other hand, summarize the prevalence of a media organization in the data. As political communication scholars, we value this information because knowing that some users more frequently share news is conceptually different from knowing that some outlets receive more traffic. That is, the demand for news by the users and reputation stock of news organizations are conceptually different from each other.

Figure 10 Theoretical Model for News Sharing

$$U_{(ij)}^k = -\alpha_{q(i)}^k \left(x_i^k - \beta_j^k\right)^2 + R_{q(i)}^k N_{ij}^k + A_i^k + G_j^k$$

I R A

Table 1: Observational data with Users (row) and Media (columns)

	M_1	M_2	M_3	.	M_J
U_1	0	2	0	4	1
U_2	5	8	2	6	4
U_3	10	5	0	0	0
U_4	0	0	0	5	9
.	.	.	.	.	.
U_I	0	5	0	1	7

Attention

Figure 2: Effect of Attention in a social media embeds. User on the left embeds more content

Reputation

Figure 1: Effect of Reputation in a social media embeds. Users on the left, center, and right of the political spectrum embed content from Media B
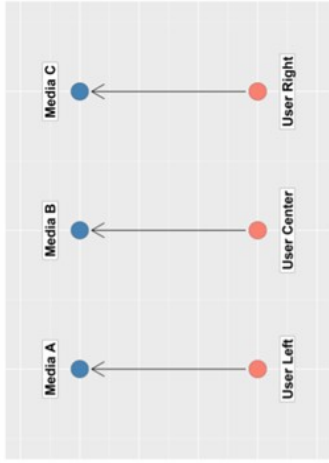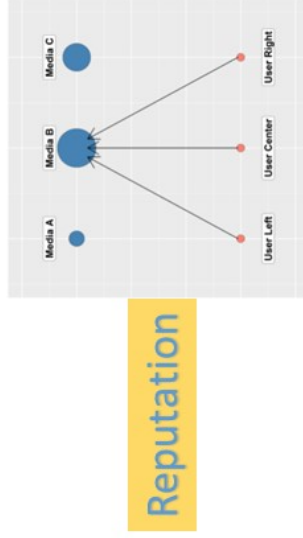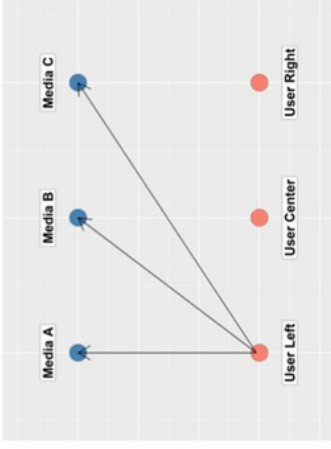

Ideology

Figure 3: Effect of Ideological Congruence in a social media embeds. Users on the left, center, and right of the political spectrum embed content to media that is ideologically closer to them.

In a statistical model, the joint estimation of random intercepts by row and by column summarize the mean counts of embeds by each user u_i and for each media m_j. For users, however, we also expect that they will share a higher proportion of news from organizations that are ideologically closer. In Figure A.1, this is described by random slopes measuring ideological congruence.

Figures A.1 summarises the intuition of each set of parameters. We expect higher reputation outlets to be broadly shared, even if they are relatively distant ideologically. We expect attentive users to share more news, even from outlets that are ideologically distant. Finally, we expect some users to more frequently share news that reflect their preferences.

Solving for equation (1) requires a rather large number of parameters. If we have measures of ideology for each user x_i and for media organizations, L_j^k, the total number of parameters still adds to $I * 3 + J$. For the Bolsonaro Network that includes 162,107 high activity accounts and 24 media outlets, the model would require a total of 486,345 parameters.

Computational demands can be reduced significantly through binning, collecting model parameters by groups of users. Rather than estimating the ideology, reputation, and attention parameters by row, we bin parameters in equally sized quantiles by the ideological location of users. We then estimate a smaller set of parameters, $-\alpha_{q(i)}^k$, $R_{q(i),j}^k$, $A_{q(i)}^k$.

$$U_{(ij)}^k = -\alpha_{q(i)}^k \left(x_i^k - L_j^k\right)^2 + A_{q(i)}^k + R_{q(i),j}^k + \gamma_{ij}^k \tag{4}$$

To estimate this model, we first estimate the ideological placement of users in social media using the Fruchterman-Reingold layout estimated in igraph 1.1 (**?**). We then create a grouping index variable by equally sized quantiles, which is used to estimate random intercepts and slopes for each of group.

We estimate our model using LMER in R 3.6, using a poisson approximation to the multinomial equation (2) of the main paper. The three sets of random slopes and intercepts, $-\alpha_{q(i)}^k$, $R_{q(i),j}^k$, $A_{q(i)}^k$, summarizes the weight of ideology, reputation, and attention in the observational data. The result return the three sets of parameters from Figure A.1.

Appendix B: Estimation of Equilibrium location of News Organizations

We begin describing the main model specification used in the paper which includes ideological proximity terms, reputation terms, and issue attention terms.[13]

$$U_{(ij)}^k = -\alpha_{q(i)}^k \left(x_i^k - L_j^k \right)^2 + A_{q(i)}^k + R_{q(i),j}^k + \gamma_{ij}^k \tag{5}$$

In Equation 5, the quadratic term $\alpha_i^k \left(x_i^k - L_j^k \right)^2$, describes the disutility of a publication by media j on issue k, with ideological leaning L that is further removed from the reader's preferred ideological position, x_i^k. Equation 5 also shows that news published by a more reputable actor, R_j^k, increase the utility of reader i. Finally, users may also give different attention to an issue, A_i^k, sharing a higher than average number of posts with social media peers. Equation 5 also includes an stochastic term that captures overdispersion, γ_{ij}^k, by user and media outlet. The subscript k might be dropped since the issue remains constant.

The statistical model maximizes the probability that a reader i will share a news item published by news organization j. As described in [omitted authors], we estimate this model using

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[13]In the paper, we analyze mostly the first two terms, and their trade-offs. The complete results are available upon request

a Poisson approximation on equation:

$$\pi_{ij} = \frac{e^{U_{(ij)}}}{\sum_{j=1}^{J} e^{U_{(ij)}}} \tag{6}$$

Once the model parameters are estimated, we follow Adams, Merrill, and Grofman (2005) and iteratively compute the equilibrium parameter $nash_j$, substituting the ideology, reputation, and attention parameters by those estimated in equation 1.

$$U_{(ij)} = -\widetilde{\alpha_{q(i)}}\,(x_i - \mathbb{L}_j)^2 + \widetilde{A_{q(i)}} + \widetilde{R_{q(i),j}}^k \tag{7}$$

The algorithm maximizes the expected market share of each news organization, $E(LS)_j$ conditional on the vector of equilibrium news locations L and the weight parameter $\widetilde{\alpha_{q(i)}}$, $\sum_j \pi_{ij}(\mathbb{L}, \widetilde{\alpha_{q(i)}})$. Adams et al. (2005) differentiate 8, solving for the last occurrence of $\mathbb{L}$:

$$\mathbb{L}_j(0) = \frac{\sum_j \pi_{ij}(\mathbb{L},0)[1 - \pi_{ij}(\mathbb{L},0)]x_i}{\sum_j \pi_{ij}(\mathbb{L},0)[1 - \pi_{ij}(\mathbb{L},0)]} \tag{8}$$

The model then iterates over each news organization until convergence is achieved. Following Calvo and Hellwig 2011, we write this model in WinBUGS 1.4.1:

```
model
 {

   for (t in 1:K) {
   #Nash Equilibrium Algorithm 1
         nash[t]~dnorm(nash.mu[t],100)
         nash.mu[t] <- mean(w1[,t])/mean(w2[,t])+xbar
         probp[t]<- mean(p[,t])
      }

   for (i in 1 : N) {        # loop around Individuals
   #x[i] ~ dnorm(mu[i],.001)
   #mu[i] <- alpha

         for (k in 1 : K) {      # loop around Media

         #Nash Model 1
         p[i,k]           <-   phi[i,k] / sum(phi[i,])
         log(phi[i,k]) <-    reputation[k] + attention[i]
                                   + alpha[i]*log(pow(l1[i]-nash[k],2))

          w1[i,k] <- p[i,k]*(1-p[i,k])*(l1[i]-xbar)
          w2[i,k] <- p[i,k]*(1-p[i,k])

   }
 }
```

Figure 11 Winbugs Equilibrium Model

Appendix C: Robustness checks: Modelling predicted probabilities of activation in two dimensions

In the main model of the paper, we estimate equation (1) reducing the information only to the first dimension of the network. This technique allows us to easily map the algorithm on 2005 and Calvo and Hellwig (2011) to our application focused on the editor's strategic positioning and polarization in social media. To provide further evidence of our argument, and to increase the robustness of our findings, we provide in this appendix a different estimation strategy.

In this appendix, we estimate the model using both dimensions of the network. Although we do not provide a solution for the optimal position of the editors, as we do in the main model of paper, we use the observational data of the #Bolsonaro network to map areas of activation for each media outlet. We read these areas as an observational representation of our findings on Figure 9. We approximate the location $\mathcal{L}_j$ deriving a weighted average of each user i location in the two dimensions of the network by the number of links embedded from each organization j. After estimating these points, we calculate the Euclidean distance between the user location and the highest density point of each media in the network. We further divide the network space in quantiles on each dimension of the network space allowing our parameters for ideology to vary spatially. We use the same generalized linear binomial count model using a logistic transformation in the multilevel framework described in the paper.

With the parameters of the model in hand, We estimate the probability of observing an embedded link in the #Bolsonaro network for each of the top 24 news organizations. Figure 12 and 13 presents the results plotted in a two dimensional space that replicates the network environment. We calculated the predicted probabilities from the estimates on the model and the

mean value of the distance of user i to media j in each grid. More black quadrants on Figures 12 and 13 represents news organization's density peak, i.e., the area of the network where the media has higher ideological congruence.
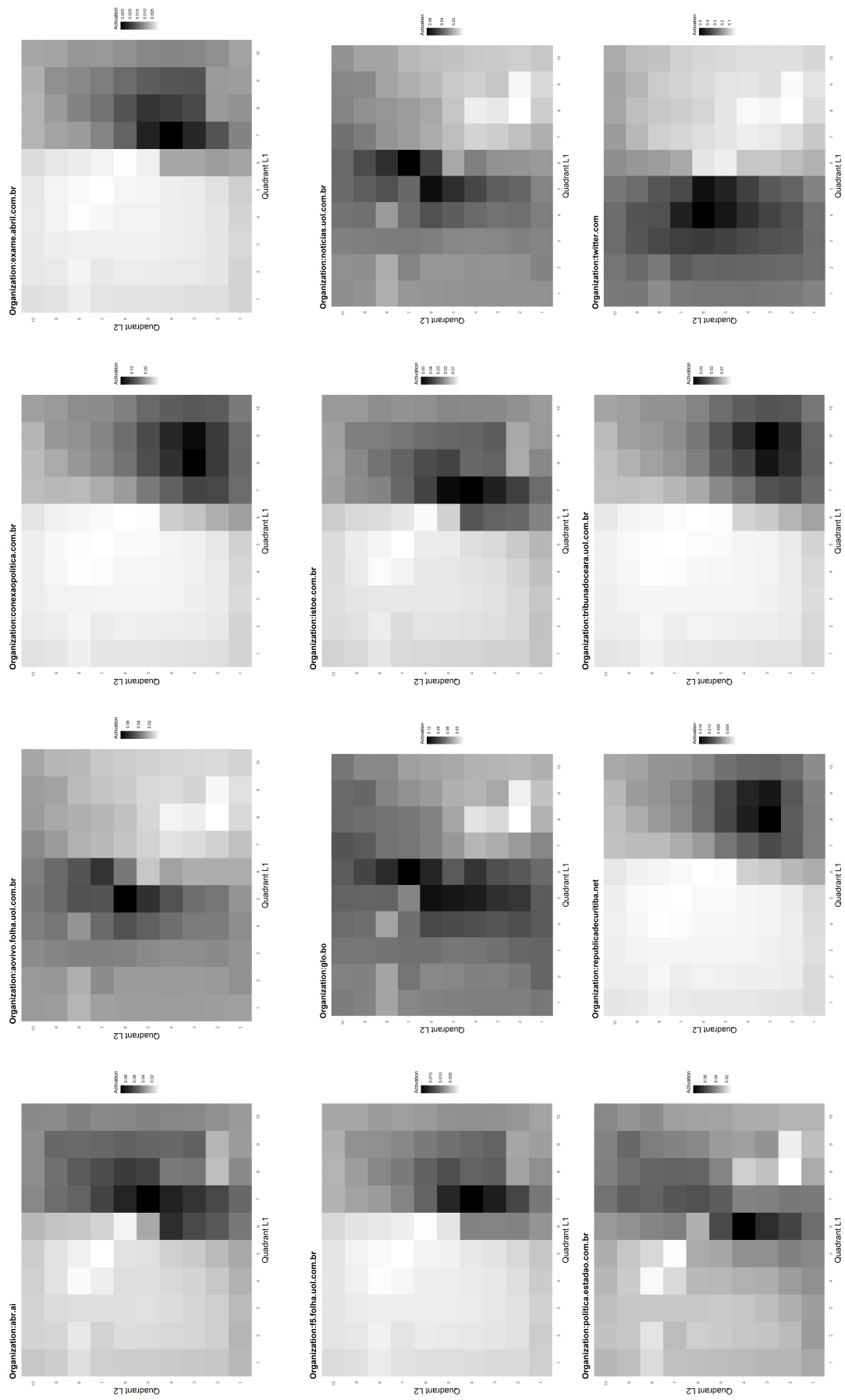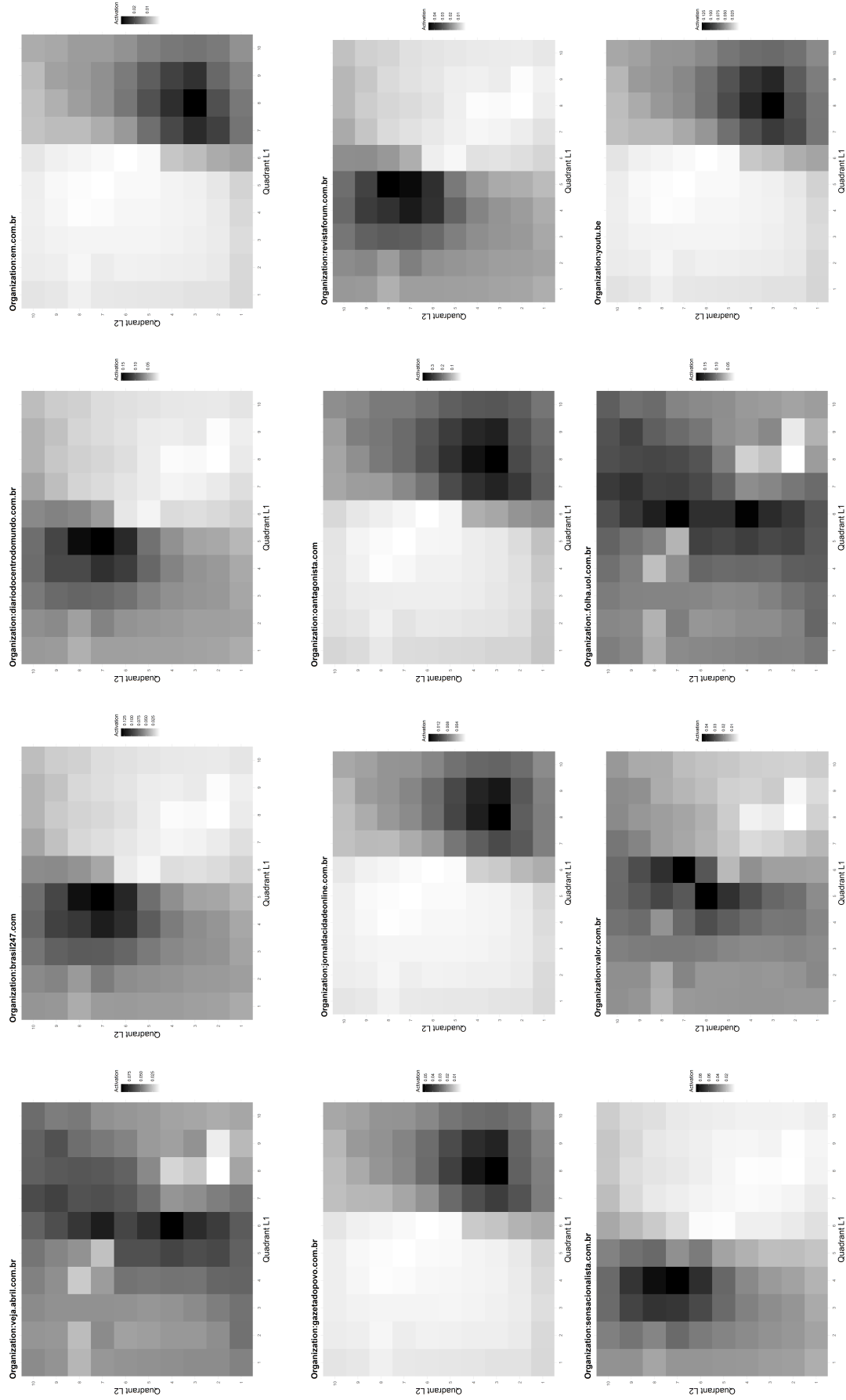
Figure 12 Predicted Rate of Embeds by Media

Figure 13 Predicted Rate of Embeds by Media

Small black grids located limited to small areas of the maps represent outlets in which the cognitive dissonance is more costly activation is not spread around the entire network. For these cases, their density in the network is concentrated on a small area with a sharp decay as one moves further away. The outlets with such a reduced area of activation converge consistent with findings of the main paper in which we indicate some media sources with low reputation and low incentive to moderation. On the other side, larger and more reputable outlets occupy mostly the center of the network, exhibit a wider area of activation, and have a lower rate of decay.

Consider for example the news organization *Revista Forum*, led by the opposition journalist Renato Rovai. At the core of the opposition, *Revista Forum* concentrates close to 8% of all embedded links. However, shared links to this newspaper rapidly drop to zero as we move to users that are not closely connected to the opposition. The same occurs in the cases of *Diario do Centro do Mundo*, *O Sensacionalista* and *Brasil 247*, all smaller organization more aligned to the opposition. On the other side, pay attention to the cases of the fake news operatives more popular in the Bolsonaro's community: *Jornal da Cidade On Line*, *Republica de Curitiba*, and *Conexão Política*. These occupy a quite isolated black area in the extreme of the bottom left quadrants of the network activating the core users of this community solely due to their strong ideological connections.

By contrast, consider now the case of *Globo* and *Folha*,[14] the largest TV channel and newspaper in the country, respectively. The most active area in the map for both, where close to 20% of all the embedded links are located, is left to the center of the network. The position is closer to the opposition community, as we would expect, but not exactly in the core of the community, and closer to the median user as our formal model predicts.

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[14]The group Folha has some distinct branches as one can see by the different links. Here, I am considering the figure related to link aovivo.folha.uol.com.br that comes directly from the leading newspaper's website.

The findings in this appendix largely support the theoretical expectations and the more complete solutions provided in the main paper.