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Is the Public Sphere Still Alive? Longitudinal Analysis of Climate Change Issue Attention Across Newspapers and Social Media Platforms (2014-2022)*

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A growing body of literature suggests that the platformization of the public sphere is eroding the public debate, thus potentially leading to the fragmentation of the public sphere. While there exists mounting evidences supporting this perspective there also exists a substantial body of literature that suggests otherwise. Within this realm of mixed evidence, studies on climate change visibility play a prominent role, presenting findings that both weaken and reinforce the fragmentation hypothesis. To investigate this matter in a context conducive for a fragmented public sphere, we collected a longitudinal (2014-2022) and cross-platform (Instagram, Facebook and Twitter) dataset (n=794.281) and correlated it with a secondary database on the press coverage of climate change in Brazil (n=3.490). Our analysis reveals a robust positive correlation between these datasets, indicating that the Brazilian public sphere retains the capacity to interconnect various arenas of visibility. We argue that this finding is particularly significant, given that it emanates from a case characterized by circumstances favoring a high degree of public sphere fragmentation. Consequently, our discovery lends support to a less pessimistic assessment of the influence of platformization on political communication within the deliberative system.

Keywords: Platformization; news media; climate change; deliberative system; fragmentation.

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The platformization of political communication refers to the increasing influence of digital platforms on how citizens access information and interact with one another to engage in political participation (SMYRNAIOS and BAISNÉE, 2023). Due to the compelling nature and market-driven rationale underpinning this phenomenon, it has progressively captured the attention of political communication scholars. This growing interest is particularly significant because platformization is often associated with political events that threaten democratic norms, including (but not limited to) political polarization, disinformation, the rise of political extremism, and formation of echo chambers (ARORA et al., 2022; BARNIDGE et al., 2021; FLAXMAN et al., 2016; HABERMAS, 2022; PFETSCH, 2020; TERREN and BRAVO, 2021).

Consequently, the platformization of political communication emerges as a primary catalyst driving the novel structural transformation of the public sphere (HABERMAS, 2022; SEELIGER and SEVIGNANI, 2021), characterized predominantly by its tribalization (MENDONÇA and AGGIO, 2023). This means that civil society is splintering into self-enclosed networks, each espousing distinct and often incompatible worldviews. This fragmentation raises concerns that the process could expand to the point where the public sphere becomes so divided that its inclusive nature is eroded (HABERMAS, 2022, 2006).

In this paper, we offer a dual contribution that centers on the interaction among the following elements: 01. the platformization of the public sphere, 02. various contingent phenomena linked to it (such as echo chambers, filter bubbles, political polarization, etc), and 03. how these phenomena relate with the hypothesis of a fragmented public sphere.

Firstly, we will try to disentangle the intricate relationships among these concepts by arguing that they describe independent and contingent phenomena. In this effort, we emphasize the understanding of public sphere fragmentation as the gradual erosion of a 'concentrated public audience' (GOMES, 2009, p. 185) that paves the way for a discursive 'besiege' around the political system (HABERMAS, 1996, p. 486). From an empirical standpoint, this phenomenon emerges as a progressive decline in citizens' engagement with pertinent issues (HABERMAS, 2022, p. 65), and as a decoupling

between the prominence of public matters in traditional news media and their representation on social media platforms (SHAO and WANG, 2017, p. 08).

Our second contribution is empirical in nature and emerges from our efforts to test if such a scenario could be found within a social environment conducive to its manifestation. In this context, we demonstrate how Brazil can be regarded as a probable instance where public discussions on social media progressively detach from the coverage provided by traditional news media outlets.

To assess the presence of this detachment, we conducted a comparative analysis of the patterns of attention to the topic of climate change over the past nine years across three major social media platforms — Instagram, Facebook, and Twitter (n=794,281). Subsequently, we established correlations between these attention cycles and the corresponding cycles derived from a secondary database (BOYKOFF et al., 2023), which encompasses the coverage of climate change by the Brazilian press (n=3,490).

Our results reveal, contrary to the aforementioned expectations, a positive correlation between them. Therefore, we conclude that the impact of social networking sites (SNSs) in fragmenting the public sphere is likely overstated. To shed further light on this finding, we explore potential research directions. We suggest that future studies might consider adopting research designs that incorporate a deeper level of analysis and encompass a wider spectrum of countries. Such research could take into account various factors, including the degree of social media penetration, the level of regulatory measures, the readership of quality newspapers, and the prevailing political stability within these countries.

This paper is structured into eight distinct sections. The initial two sections provide a comprehensive review of both theoretical and empirical literature pertaining to the consequences of media system platformization on the public sphere, including influential literature on climate change communication. The third section elaborates on the distinctive attributes of the Brazilian media system, as well as the landscape of climate change communication within it, which collectively create a conducive environment for the emergence of a fragmented public sphere. In the fourth section, we present our hypotheses derived from the literature review. Subsequently, the fifth section describes our research design and methodology. The sixth segment offers a detailed presentation of our results, substantiated by graphical

representations and tabulated data showcasing the outcomes of our statistical tests. The seventh section engages in a comprehensive discussion of our findings, along with the theoretical implications they carry. Finally, in the concluding portion, we address the limitations inherent in our research design and identify potential avenues for future research. We outline how forthcoming studies could bridge existing gaps in knowledge concerning the impact of platformization of political communication within the deliberative system.

Social media and the public sphere: a dysfunctional deliberative system?

The fundamental concept of deliberative democracy is intricately tied to the notions of the public sphere (AVRITZER and COSTA, 2004; HABERMAS, 2022, 1996) and deliberative system (MANSBRIDGE 1999, see also HAUBER and MOTTA, 2020; MAIA, HAUBER, and CHOUCAIR, 2023). Notably, there is a growing apprehension among scholars concerning the magnitude and implications of the escalating influence exerted by social media platforms over citizens' perceptions of and involvement in politics. This concern has led to the recognition of a novel structural transformation of the public sphere, discernible across various levels of manifestation (HABERMAS, 2022; SEELIGER and SEVIGNANI, 2021). In a similar vein, Mendonça and Aggio (2023) describe this new structural transformation as the tribalization of the public sphere, emphasizing its capacity to reshape the terrain of political and civic engagement.

In this context, the looming danger of fragmenting the public agenda into disparate 'parallel issue agendas' (PFETSCH, 2020, p. 102) stands out as one of the most concerning risks associated with the emerging structural transformation of the public sphere. Habermas (2022) underscores this apprehension in his recent elaboration on the subject:

A democratic system as a whole is damaged if the infrastructure of the public sphere can no longer draw the attention of citizens to relevant issues that require decision-making and can no longer guarantee the formation of competing public opinions, which means: qualitatively filtered opinions.¹ (HABERMAS, 2022, p. 65).

¹Free translation of "Ein demokratisches System nimmt im Ganzen Schaden, wenn die Infrastruktur der Öffentlichkeit die Aufmerksamkeit der Bürger nicht mehr auf die relevanten und entscheidungsbedürftigen Themen lenken und die Ausbildung konkurrierender öffentlicher, und das heißt: qualitativ gefilterter Meinungen nicht mehr gewährleisten kann" (HABERMAS, 2022, p. 65).

The apprehension that social media platforms could undermine the very foundation of the public sphere is rooted in the shifting media consumption patterns of the populace, with traditional news media being supplanted by engagement with these platforms. Rau and Stier (2019) outline how existing scholarship often expresses concern about the potential emergence or reinforcement of echo chambers which, in turn, could lead to the fragmentation of the public sphere by rendering the public debate inconceivable.

Magin, Geiß, Stark, and Jürgens (2022) provide evidence that aligns with the aforementioned concerns. Their study demonstrates that extremist individuals who eschew traditional news media experience an erosion of what they term 'issue horizons'. Given the contemporary prevalence of political extremism, this recent empirical insight could potentially cast doubt on the descriptive framework presented by Neuman et al. (2014), in which the agenda of digital media is closely aligned with that of mainstream news media.

Shao and Wang (2017) further contribute to this line of thinking by presenting evidence from the Chinese public sphere. They spotlight a particular controversy involving an online video player company, where the company's legal prosecution by Chinese authorities garnered substantial attention on social media but received limited coverage from traditional news outlets. Consequently, this case presents a scenario where the importance of issues diverges between news media and social media platforms.

When traditional news media downplays the visibility of a political issue that social media interactions indicate as significant to the broader public, it impedes the participation of individuals who don't rely on social media platforms to stay informed about current events. This reduction in the prominence of vital public concerns contributes to the isolation of individuals from the central matters of the nation.

Conversely, a reverse scenario may arise when engagement with social media platforms is linked to a detachment from issues deemed crucial by the broader public. Employing a blend of Web-tracking and survey data, Cardenal, Galais, and Majó-Vázquez (2019) illustrated this phenomenon with precision within the Spanish populace, particularly in the context of news consumption through Facebook.

On the other hand, amidst the era of platformization in political communication, there is evidence suggesting that significant areas of common ground persist. In this direction, Lycarião and Sampaio (2016) make sense of mixed evidence regarding the power of social media in setting the public agenda by proposing an interactional model of the agenda-setting process, through which they explore the interconnectedness of online and offline media through diverse actors who share a unified public agenda.

Jungherr et. al. (2017) shed light on this process by analyzing data from Twitter and correlating them with opinion polls in Germany. Their findings indicate that users' political attention may fluctuate based on political events and the extent of news media coverage on political topics. While they acknowledge the inability to forecast election outcomes, their analyses suggest that social media data can anticipate broader political attention dynamics. This, in our perspective, provides evidence of an interconnected media environment inducing connectivity within the deliberative system (MENDONÇA, 2019).

Similarly, Rau and Stier (2019) provide a literature overview wherein they conclude that concerns regarding societal fragmentation through digital media and the resulting political polarization lack empirical support. Drawing on existing research, they assert that they have not observed any fragmentation of public attention across political preferences. Likewise, Mahrt (2019) echoes this assessment, highlighting that “so far, the evidence does not suggest widely separated niches of people who lose touch with other audiences” (MAHRT, 2019, pp. 46-47). In this context, McCombs and Valenzuela (2020) conducted a review of contemporary literature that lends support to the hypothesis that news media's ability to shape the public agenda remains intact, even within societies characterized by substantial levels of digitalization.

Consequently, as scholars continue to unravel the precise role of social media platforms in reinforcing echo chambers (TERREN and BRAVO, 2021), exacerbating political polarization (ARORA et al., 2022), and promoting selective exposure (BARNIDGE et al., 2021), the aforementioned evidence contributes to the understanding that these dissonant elements “singled out by many scholars in relation to the public sphere do not necessarily lead to the disappearance of a public agenda (BENTIVEGNA and ARTIERI, 2020, p. 08).

Considering these contributions, we posit that it is crucial to differentiate between contingent phenomena associated with the platformization of political communication (such as filter bubbles, echo chambers, political polarization, etc) and the distinct scenario of a fragmented public sphere.

Table 01 summarizes the notion that although social media platforms may indeed amplify selective exposure, audience fragmentation, and ideological polarization, these outcomes do not necessarily result in the fragmentation of the public sphere. This is attributed to the possibility of such ideological insulation either leading to the formation of entirely separate political agendas or the establishment of networks that utilize completely different frames, arguments, and sources to interpret a shared public agenda.

Table 01. Definitions of a fragmented public sphere

Fragmentation of the public sphere	Contingent Phenomena
Lack of citizens' attention to relevant issues (HABERMAS, 2022, p. 65).	Echo Chambers (SUNSTEIN, 2001; TERREN and BRAVO, 2021)
Erosion of the public agenda (CARDENAL et al, 2019)	Filter bubbles (FLAXMAN et al., 2016; PARISER, 2011)
Erosion of issue horizons (MAGIN et al., 2022)	Ideological segregation (FLAXMAN et al, 2016)
Decoupling between the salience of public issues in news and social media (SHAO and WANG, 2017, p. 08)	Audience fragmentation through selective exposure to (hyper) partisan news (e.g. BARNIDGE et al., 2021)
Reduction of news media's ability to shape the public agenda (CHAN and LEE, 2014, p. 311)	Political polarization or fragmentation (ARORA et al., 2022)

Source: Elaborated by the authors.

With these distinctions clarified, the fragmentation of the public sphere arises when 'parallel issue agendas' emerge, 'issue horizons' erode, or when the public sphere "can no longer draw the attention of the citizens to the relevant issues" (HABERMAS, 2022, p. 65). In empirical terms, this means that various groups or ideological networks prioritize their favored topics while disregarding others, including those outlined in the official public agenda established by the political system. Another approach to identify this phenomenon, which our research design employs, involves examining the prominence of issues in mainstream news media and on social media platforms (SHAO and WANG, 2017). Through this examination, one can measure the extent of convergence or divergence in attention on political issues, thereby providing evidence for or against the hypothesis of fragmentation. In the next section, we demonstrate how

the literature on climate change communication offers a promising case for testing the extent to which this hypothesis holds true under such conditions.

Climate and media changes: impacts on the deliberative system

Climate change stands as one of the most extensively examined subjects that illustrates the intricate interconnectedness of diverse arenas of deliberation, where newspapers play a significant role in disseminating essential political and scientific arguments on this issue (REYES et al., 2015; LÜCK et al., 2018; WESSLER et al., 2016). Collectively, this body of literature reveals that traditional news media outlets, at the very least, signal to their audience the relevance of the topic and offer avenues for the formation of opinions (SCHMIDT, IVANOVA and SCHÄFER, 2013, p. 1245).

There are instances that further exemplify this positive interplay, such as the case of Urgenda against the Dutch government (WONNEBERGER and VLIEGENTHART, 2021). In this case, quality newspapers² played a pivotal role in a virtuous cycle that “contributed to parliamentary attention for climate policies” (WONNEBERGER and VLIEGENTHART, 2021, p. 710). Additionally, Lycarião and Wozniak (2017) found that the news media’s peak of attention regarding the COP-15 in Copenhagen coincided with the peak of engagement with the official website of the governing body responsible for the event, namely, the UNFCCC (United Nations Framework Convention on Climate Change).

In the realm of online media and the interplay between climate change attention and associated events (such as international summits, scientific reports, protests, etc), several studies have revealed a reciprocal relationship between these events and the flux of attention spanning social media platforms and news media (CHEN et al., 2022; LÖRCHER and NEVERLA, 2015; MAVRODIEVA et al., 2019; ALONSO, CORRAL and MOYA, 2021). Consequently, these investigations portray climate change as one of the rare topics capable of setting an international public agenda, with discussions primarily revolving around strategies for addressing the issue rather than questioning its legitimacy (CHEN et al., 2022).

²The expression 'quality newspapers' describe news media outlets that have historically been seen as placing importance on hard news (especially on politics and economy) and on a reliable 'information-focused' approach (LEFKOWITZ, 2018).

On the other hand, studies relying on digital trace data, as demonstrated by Terren and Bravo (2021), depict a less optimistic scenario. In this context, Kaiser and Puschmann (2017) furnish evidence that in the realm of online communication, climate skeptics tend to be confined within their online echo chambers, while scientific actors exhibit relatively weak connections with other types of participants. All of this suggests a “rift between politics, science, and civil society” (KAISER and PUSCHMANN, 2017, p. 382). Furthermore, research by Esparcia and Gómez (2021) highlights that far-right news media outlets either offer minimal attention to the issue (e.g., Fox News) or engage in contestation by promoting skepticism and scientific denialism concerning climate change (e.g., Breitbart News).

From our perspective, a valuable approach for gauging the fragmentation of the public sphere involves integrating digital trace data with data from quality newspapers. Considering that newspapers hold a central role in shaping the public agenda (McCOMBS and VALENZUELA, 2020), it becomes pertinent to ascertain the degree of correlation between direct user interactions on social media and the visibility of news media. This type of investigation would prove especially insightful in a society characterized by substantial social media engagement, political instability, and prevalent far-right digital activism. The following section elaborates on how Brazil presents a relevant case study in this context.

Brazil as a strong candidate for the fragmentation hypothesis

Canclini (2020) explored the digitalization of the public sphere in Latin America, emphasizing its impact on the erosion of public discourse and democratic processes. These transformations have led to adverse repercussions on both public and political debates. Kubin and von Sikorski (2021) underscored this in their systematic review of English-language literature, noting that the focus is predominantly on the United States.

Regarding Brazil, Santos Jr. and Albuquerque (2019) highlight the significant visibility of a far-right network on Facebook during the 2018 presidential elections. According to a media effects study conducted by Mundim, Vasconcellos and Okado (2022), this played a crucial role in the electoral success of Jair Bolsonaro, a prominent figure within Brazil's far-right. As indicated by the findings of Magin et al. (2022), the

risk of a severe fragmentation of the public sphere escalates as more citizens become extremists and rely on social media to obtain political (dis)information.

In this regard, Brazil stands out as a compelling case due to its unique combination of the following distinct characteristics:

01. population with a high level of internet access (77%) (NEWMAN et. al., 2022, p. 117);
02. a predominant reliance on social media as the primary source of information (NEWMAN et. al., 2022, p. 117);
03. the lack of a public communication system that establishes a shared news source for different political leanings (ORTH and SOARES, 2020);
04. the emergence of a far-right digital activism that quickly mastered the strategic use of social media to gain more visibility than other political factions, sometimes even surpassing the reach of most traditional news outlets (CHAGAS et al., 2022; CESARINO and NARDELLI, 2021; MUNDIM, VASCONCELLOS and OKADO, 2022; ROCHA and MEDEIROS, 2021; SANTOS JR., 2022, 2021).
05. remarkably low and declining levels of newspaper readership (NEWMAN et. al., 2022, p. 27).

Overall, these structural settings provide fertile soil for climate change denialism.

In this regard, Miguel (2022) meticulously reconstructed the orchestrated endeavors of climate denialists in Brazil from the late 2000s onward. The author identified a network of actors that played a pivotal role in amplifying the visibility and political influence of climate denialism. This network includes media pundits, fringe climate scientists, conservative sectors of the Catholic Church, rural associations and their corresponding political representatives in Congress.

However, Miguel (2022) points out that this network increased its political influence and prominence following Jair Bolsonaro's rise to power in 2018, along with the emergence of far-right organizations such as Movimento Brasil Livre (MBL). These organizations demonstrated remarkable proficiency in disseminating climate change denialism through social media platforms, particularly on Youtube.

This observation is further supported by the data provided by Santini et al. (2023). Their findings demonstrate that far-right networks aligned with former President Jair Bolsonaro exhibited exceptional effectiveness in spreading social-environmental denialism through social media platforms, with Facebook and YouTube emerging as prime conduits for dissemination. Conversely, Instagram and Twitter show a different pattern, with prominence given to political figures and celebrities affiliated with socio-environmental movements (SANTINI et al., 2023).

Nonetheless, one must approach the relatively stronger presence of climate activists on certain social media platforms with a degree of caution. As highlighted by Esparcia and Gómez (2021) in the United States, a parallel scenario might be unfolding in Brazil, where denialists could be adopting a strategy akin to their counterparts on television channels — essentially ignoring the topic of climate change altogether. This approach aligns with the concept of ‘denialism by silence’, as astutely articulated by Painter and colleagues (2023). Their study suggests that this tactic emerged as the primary strategy for center-right and right-leaning broadcasting networks that lent support to Bolsonaro's administration in Brazil from 2019 to 2022.

If indeed ‘denialism by silence’ stands as the primary strategy of climate denialists in Brazil, this would signify a more alarming consequence for the public sphere. In this scenario, rather than witnessing polarization or agonistic contestation, one would find the erosion of the so-called ‘issue horizons’ (MAGIN, GEIß, STARK, and JÜRGENS, 2022). Consequently, the subject of climate change would become confined to a political niche, resulting in a corresponding discourse that fails to engage a broader public audience, which, in turn, is necessary for the public sphere to mobilize a discursive siege around political institutions (HABERMAS, 1996, p.486).

In summary, these distinctive attributes position Brazil as a compelling contender for harboring a fragmented public sphere. This hypothetical scenario envisions a landscape where the realms of visibility and deliberation are so profoundly disconnected from each other that it prevents the emergence of a shared agenda across these arenas.

On the other hand, much of the available evidence on the climate change debate indicates that this topic garners attention across both news media and social media domains (ALONSO, CORRAL and MOYA, 2021; CHEN et al, 2022; LÖRCHER and

NEVERLA, 2015; MAVRODIEVA et. al, 2019). It is noteworthy that much of this evidence originates from countries characterized by higher levels of newspaper readership, political stability, and lower levels of far-right digital activism. Taking these considerations into account, our research question follows:

Research Question (RQ)

What is the magnitude and direction of the correlation between press coverage and social media activity concerning the fluctuations in attention towards climate change in Brazil?

Hypotheses

As previously shown, an expanding body of literature offers compelling evidence of the fragmentation of the public sphere due to the affordances of social media and their increasingly influential role in shaping how citizens consume political information (CARDENAL et al., 2019; MAGIN et al., 2022; SHAO and WANG, 2017). Taking this into account, Brazil stands out as a prime example of a fragmented public sphere, given its heavy reliance on social media for accessing news (NEWMAN et. al., 2022, p. 117). Furthermore, these social media platforms are dominated by hyperpartisan organizations that consistently question the credibility of conventional news outlets (CESARINO and NARDELLI, 2021; CHAGAS et al., 2022; SANTOS JR., 2023, 2022, 2021; MIGUEL, 2022; SANTINI et al., 2023). As a result, it is reasonable to expect that social media visibility in Brazil is decoupled from news media visibility, especially regarding mainstream topics such as climate change. Hence, drawing from this body of literature, we posit the following null hypothesis:

H0: There is a weak or negligible correlation between fluctuations in the visibility of the topic of climate change on social media and the corresponding coverage in news media.

On the other hand, Neuman et. al. (2014), Lycarião and Sampaio (2016), Jungherr et. al. (2017), Mahrt (2019), Rau and Stier (2019), and McCombs and Valenzuela (2020) have presented or summarized evidence that the fragmentation hypothesis might be overstated. This literature allows us to conclude that social media

platforms neither block their users from accessing different points of view nor they are disconnected from variations in issue attention in the news media. Thus, we may propose the following alternative hypothesis:

H1: There is a positive correlation between fluctuations in the visibility of the topic of climate change on social media and the corresponding coverage in news media.

Method

To test the hypotheses above, we compiled two distinct datasets. The first encompasses social media interactions related to the topic of climate, while the second comprises news coverage of the same topic by quality newspapers in Brazil.

By combining digital trace data with data from offline versions of quality newspapers, we mitigate the methodological biases identified by Terren and Bravo (2021). Moreover, this combination of datasets allows us to evaluate whether the cycles of attention between press coverage and social media fail to align.

To compile the press coverage dataset, we utilized the publicly available database provided by Boykoff et al. (2023). The Brazilian portion of the sample consists of two quality newspapers, namely O Globo (n=1,787) and Folha de São Paulo (FSP) (n=1,703), resulting in a total of 3,490 news articles within the specified time frame. The data collection process, as outlined by Boykoff et al. (2023), involved extracting news articles from these newspapers containing the keywords 'aquecimento global' (global warming) or 'mudanças climáticas' (climate change).

To construct the social media dataset, we adopted a multiplatform approach, encompassing Facebook, Instagram, and Twitter. This cross-platform strategy ensures that our findings can be generalized across social media use rather than being confined to a single platform. When assessing the suitability of social media platforms for scholarly examination, we considered two key criteria: 01. the accessibility and availability of data, and 02. the relevance of these platforms as primary sources for news consumption within the country under investigation.

Regarding the first criterion, we employed CrowdTangle, a well-established social analytics tool. CrowdTangle offered us access to historical datasets from various public fan pages on both Facebook and Instagram. To analyze Twitter, we used the Academic API (Application Programming Interface) for collecting a chronological series of past tweets.

The second criterion takes into account the popularity and significance of these platforms within the Brazilian context. Facebook and Instagram stand out as the most widely used platforms in Brazil, as supported by data from Newman and colleagues (2022). However, Twitter holds particular importance for tracking political discourse due to features that facilitate political engagement, as highlighted by Santos (2022). Moreover, Twitter's user profile is often likened to that of a typical newspaper reader, as suggested by Laor (2022).

Our approach to collect the social media dataset involved gathering public posts containing the keywords 'aquecimento global' (global warming) or 'mudanças climáticas' (climate change). We conducted the data collection in June 2023, spanning from January 2014 to December 2022. This time frame was chosen based on insights from earlier studies, which indicated that far-right digital activism began to dominate social media visibility from 2014 onwards (SANTOS JR., 2022, 2021).

During the data preparation phase, we excluded posts generated by official profiles of the newspapers Folha de S. Paulo and O Globo across all three platforms, along with posts that explicitly referenced URLs from these newspapers. This procedure enhances the validity of our data, contributing to a more accurate reflection of interactions originating from social media users. These measures resulted in the removal of about 1% of the total posts. Additionally, prior to and after implementing this step, we conducted comparative statistical analyses, which revealed no significant alterations in the outcomes.

The data collection and curation from social media platforms resulted in a total of 160,369 posts from Facebook, 55,526 posts from Instagram, and 578,385 tweets. The larger number of units on Twitter can be attributed to the platform's specific features and data availability through the API. It's important to note that each textual interaction, such as replies and retweets with comments, creates a new unit on Twitter, whereas the same does not occur on Facebook and Instagram.

To mitigate this discrepancy, we applied treatment measures to the Twitter data. Specifically, we excluded tweets that met at least one of the following criteria: 01. contained the textual pattern "RT @"; 02. featured identical text; 03. exhibited a text similarity greater than 0.7.

We also normalized the remaining volumetric discrepancies within a bounded scale ranging from 0 to 100 (Figure 01). This standardization method offers the advantage of providing a consistent comparative scale across varying magnitudes of quantitative differences.

All data collection, processing, statistical tests, and graph creation were conducted using the R programming language. The scripts and data used for these analyses can be accessed in the Annexes³ for the purposes of transparency and replication.

Results

To visualize the fluctuations in attention to climate change on each arena of visibility under investigation, we plotted their temporal graphs. Figure 01 illustrates the variation over time (2014-2022) on the topic of climate change on social media and in press coverage. The curves exhibit strikingly similar patterns, especially for Facebook, Instagram, and the press coverage. Notably, the most prominent peaks align, occurring in November 2021 and November 2022. These peaks coincide with the 26th and 27th United Nations Climate Change Conference of the Parties (COP-26 and COP-27), held in Glasgow (UK) and Sharm El Sheikh (Egypt), respectively.

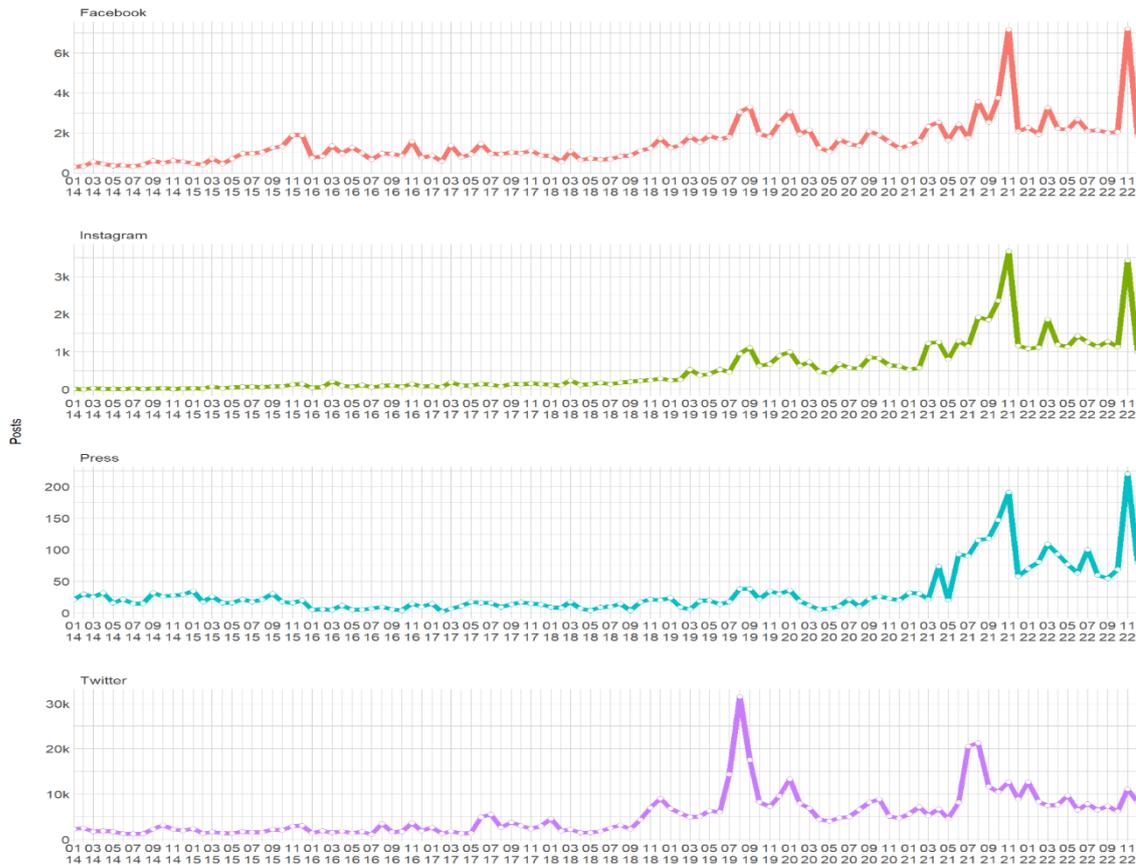
In contrast, Twitter follows a distinct trajectory. Unlike the other platforms, its highest peak occurred in August 2019. A manual examination of the dataset indicates that this peak was primarily driven by a series of tweets with an ironic tone concerning global warming⁴.

To verify the level of statistical correlation between these arenas of visibility, we used the Pearson correlation coefficient, with each month serving as the unit of analysis. This resulted in 108 observations. Initially, we examined the total counts of all social media posts in relation to the combined press news, yielding a correlation coefficient of $r=0.671$ ($p<0.0001$) (Table 02).

³Harvard Dataverse.

⁴The most retweet message reads 'será que vou conseguir me formar na faculdade antes do aquecimento global matar todo mundo', which could be freely translated as: 'Will I be able to graduate from college before global warming kills everyone?' Original tweet available at <<https://twitter.com/selegmx/status/1162740863539318784>>.

Figure 01. Monthly variation of the topic in newspapers and on social media



Source: Created by the authors based on data from Instagram, Facebook, Twitter and Boykoff et al. (2023).

Table 02. Correlation matrix for the arenas of visibility (social media x press)

	Social Media	Press
Social Media		0.671 (<.001)
Press	0.671 (<.001)	

Source: Created by the authors based on data from Instagram, Facebook, Twitter and Boykoff et al. (2023).

Note: Computed correlation used Pearson-method with listwise-deletion.

Given Twitter’s distinct pattern, it’s plausible that this contributes to a lower coefficient. As a result, we further examined the disaggregated counts for each social media platform in relation to national news. The resulting correlations are presented in Table 03. The weakest correlation is observed between Twitter and the press ($r=0.53$), whereas the strongest is between Facebook and Instagram ($r=0.938$). Remarkably, the press exhibits its highest correlation with Instagram ($r=0.90$), a

notably high score in social science standards. Similarly, Facebook demonstrates a strong correlation ($r=0.82$). All correlations maintain statistical significance at $p<0.0001$.

Table 03. Correlation matrix for all arenas of visibility

	Facebook	Instagram	Twitter	Press
Facebook		0.938 ($<.001$)	0.658 ($<.001$)	0.821 ($<.001$)
Instagram	0.938 ($<.001$)		0.643 ($<.001$)	0.909 ($<.001$)
Twitter	0.658 ($<.001$)	0.643 ($<.001$)		0.538 ($<.001$)

Source: Authors with data from Instagram, Facebook, Twitter and Boykoff et al. (2023).

Note: Computed correlation used pearson-method with listwise-deletion.

Discussion

This paper aimed to evaluate two hypotheses. The null hypothesis (H0) corresponds to the notion of a fragmented public sphere resulting from the platformization of political communication, while the alternative hypothesis (H1) posits the minimal condition for a functional deliberative system — a shared agenda across different visibility arenas. To assess whether the public sphere preserves its function and inclusive character, we relied on previous research that utilized the detachment between the agendas of the traditional press and social media to identify the fragmentation of the public sphere (SHAO and WANG, 2017).

The correlation scores and visual evidence presented earlier strongly support our research hypothesis (H1), indicating a clear convergence between news media and social media platforms regarding their attention variations on the topic of climate change.

This finding is particularly notable given that Brazil might be considered a strong candidate for showcasing a heavily fragmented public sphere driven by online social media. It's worth noting that Twitter exhibited a positive correlation with newspaper attention, albeit to a lesser extent than Facebook and Instagram. This result is unexpected, given that Twitter's user profile is typically thought to be more aligned with the characteristics of the average newspaper reader (LAOR, 2022).

This finding warrants further data collection and in-depth analysis for a comprehensive understanding. Nevertheless, if Twitter users tend to be more politically active, this could potentially foster an environment more conducive to

hyperpartisan and unconventional behavior compared to larger social media platforms. Consequently, future research could explore cross-platform research designs to determine if this trend holds true for Twitter across different subjects and countries.

Even more surprising were the higher correlation scores for Facebook and Instagram, which are the most widely used platforms in the country. Despite Facebook's well-documented role as a platform for the success of the Brazilian far-right (CESARINO and NARDELLI, 2021; CHAGAS et al., 2022; MIGUEL, 2022; MUNDIM, VASCONCELLOS and OKADO, 2022), our findings also provide evidence that the entire population can align around a shared agenda on a vital and pressing issue. Notably, Facebook, Instagram, and quality newspapers exhibited identical peaks of attention at the close of 2021 and 2022 during the COP-26 and COP-27 conferences held in Glasgow and Sharm El Sheikh, respectively.

This finding is consistent with prior research underscoring the significance of international summits as major drivers for news coverage on climate change (LÖRCHER and NEVERLA, 2015; REYES et al., 2015; SCHÄFER, IVANOVA and SCHMIDT, 2014). Notably, our data reveal that this triggering effect also extends to social media, even in a country characterized by unfavorable conditions for a robust alignment between the attention cycles of newspapers and those of social media. Consequently, this offers a less pessimistic outlook regarding the potential impact of social media on the fragmentation of the public sphere.

However, a less pessimistic outlook does not equate to an optimistic one. The fact that various arenas of visibility and political discourse share a common agenda does not automatically lead to a rational public debate grounded in reliable information. In this context, there is significant evidence indicating the frequent occurrence of tactics such as misinformation, hate speech, and other forms of counter-deliberative behavior on social media platforms (CHAGAS et al., 2022; GOMES and DOURADO, 2019; MAIA and REZENDE, 2016; SANTINI et al., 2023; SANTOS JR., 2022). It remains to be seen through future research whether this dynamic extends to the climate change debate over the long term.

At this stage, our research has successfully identified a convergence in the attention cycles concerning the topic of climate change across vastly different arenas

of political visibility. However, we cannot assert, as some might expect, that this shared attention is not accompanied by deeply isolated political factions employing entirely distinct frameworks, arguments, and sources to interpret the subject (e.g. ZHANG et al., 2023). Further investigation is needed to evaluate this scenario, which could benefit from a combination of content analysis and social networking analyses (e.g. LYCARIÃO and SANTOS JR., 2017).

Nonetheless, the fact that the research design of our paper did not identify the level of insulation of social networks or their ideological polarization is not necessarily a limitation according to the theoretical framework outlined in Table 01. This is because political or audience fragmentation, or even the existence of echo chambers, are not inherently problematic for deliberative democracy. Instead, they might align with the characteristics of a pluralistic public sphere, as proposed by Habermas (1998, 1996). What remains incompatible is the presence of hate speech, disrespect, and violence directed toward other groups.

This perspective finds support in empirical research consistently showing that interactions across different networks tend to be associated with hate speech and anti-deliberative behavior, rather than contributing to a constructive political discourse (LYCARIÃO and SANTOS JR., 2017; SCHLÖGL et al., 2022). Consequently, if social networking analyses are indeed capable of assessing interactions between networks and, as a result, online political polarization, one should also approach their validity as an indicator of integrated and healthy public deliberation with skepticism.

With that being said, exchange of arguments and interactions across ideological factions are indeed expected to occur in the core of the political system (HABERMAS, 1996). Accordingly, one should expect political perspectives engaging in the exchange of arguments (and compromises) in front of society as a whole (HABERMAS, 1996). To facilitate this, the media system assumes a pivotal role, not only by rendering this exchange of arguments and compromises visible, but also by making it accountable and comprehensible to a heterogeneous citizenry (LYCARIÃO and WOZNIAK, 2017).

Our results provide further empirical evidence for this understanding, as the peaks of attention on climate change, observed across both traditional news outlets and social media platforms, coincided with moments of major political decisions (i.e. the COPs). The significance of this finding hinges on the assumption that this

concentrated public attention is crucial for materializing the discursive besiege around political institutions we discussed in the initial sections of this paper.

Limitations and future research

By combining digital trace data with newspaper coverage, this study has uncovered unexpected interconnections between social media and news press coverage pertaining to a significant public concern. However, the effective functioning of the deliberative system demands more than just the interplay of diverse arenas of visibility. It also requires reason-giving, intelligibility, justification, and a well-informed citizenry (HABERMAS, 1996; LYCARIÃO and WOZNIAK, 2017; MAIA, HAUBER, and CHOUCAIR, 2023; MENDONÇA, 2019). In this regard, our findings fall considerably short of providing substantiation for these additional normative expectations.

Notwithstanding these limitations, our study demonstrates that the final barrier preventing an acute level of public sphere fragmentation remains intact, acting as a safeguard against complete disintegration. This implies that the communicative strength of a dynamic public sphere retains its empirical potential even within societies marked by substantial indications of a profoundly malfunctioning deliberative system, particularly in the aftermath of the prevalent counterpublicity of the Brazilian far-right during Bolsonaro's administration (ROCHA and MEDEIROS, 2021).

Hence, future research could explore whether the synchronized attention cycles observed between quality newspapers and social media concerning climate change are similarly mirrored in formal domains of the political system (e.g., parliamentary hearings and debates). In such endeavors, it would be advantageous to ascertain the primary sources of information shaping public discourse across various arenas of visibility and public deliberation. To accomplish this, the method proposed by Santos (2021) provides a valuable tool for assessing the comparative influence of traditional news media versus hyperpartisan sources, potentially shedding light on the extent to which the platformization of political communication in Brazil has corresponded with the empowerment of far-right media outlets and their 'dominant counterpublicity' (ROCHA and MEDEIROS, 2021).

In terms of future research, while Brazil presents favorable conditions for the fragmentation hypothesis, it is not the sole country in this situation. Other nations

characterized by heightened political instability and polarization could be similarly explored. An empirical challenge in this pursuit entails refining the process of filtering social media data by country and employing a more comprehensive vocabulary encompassing the topic. This is required due to the existence of alternative references to climate change that we were not able to include in our data collection, such as the specific terms favored by climate skeptics (e.g. 'climate hoax'). Future research should aim to address these limitations inherent in our research design.

Furthermore, it's crucial to recognize that countries are intricate entities for analysis, and any comparison must contend with the inherent limitations of small-scale studies amidst a multitude of intervening variables. Among these factors, the capacity of a political system to regulate hate speech, disinformation, and seditious activities must be considered. As seen in the Brazilian case, social media can serve as potent tools for propagating these detrimental actions against democracy, particularly when the political system has not yet been designed to effectively counteract them.

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