Network Activated Frames:

Content Sharing and Perceived Polarization in Social Media

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Abstract

Our paper describes how the users' decisions to share content alter the frequencies of the frame elements observed by social media peers. Changes in the frequency of distinct frame elements, in different regions of a social network, shape how individuals interpret, classify, and define situations and events. We label this process *Network Activated Frames* (NAF). We test the mechanisms behind NAF with an original image-based conjoint design that replicates network activation in three surveys. Results show that partisans share *more* content than non-partisans and that their preferences are *different* from that of non-partisans. Our findings show that a network of peers with cross-cutting ideological preferences may be perceived as a bubble if partisans amplify content they like at higher rates. Beginning with fully randomized probabilities, the output from our experiments is more extreme than the preference of the median users, as partisans activate *more* and *different* frame elements than non-partisans. We implement the survey experiments in Argentina, Brazil, and Mexico.

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In today's social media environment, the activation and propagation of content requires users to share posts published by their peers. As users share posts, they make content available to a wider public. In this paper, we describe how the sharing behavior of interconnected users alters the frequencies of the texts, images, and endorsements observed in a network (Aruguete and Calvo, 2018; Entman and Usher, 2018). We define this process as *Network Activated Frames* (NAF), whereby users *frame events* by *sharing content* in social networks.

Changes in the frequency of frame elements in distinct regions of a social network shape how individuals interpret, classify, and define situations and events. Understanding the users' decisions to share content, as well as the content users expect to see activated by their friends, is critical for explaining framing in social media.

Most importantly, differences in the user's decision to share content (self) and in the content user's expect to see shared by others (peers), allow us to explain the subjective perceptions of *social media bubbles* (Alipourfard et al., 2020; Lee et al., 2019; Jackson, 2019). That is, the perception of a highly polarized social media environment when the preferences of more active nodes are overrepresented in the data. In this paper we show that

if partisans share *more* frames and if partisans share *different* frames, the overall content present in social media networks will be highly partisan. In our fully randomized experiment, where *input* frames are presented to respondents with equal probability, *output* frames overrepresent the preferences of partisan respondents.

Our findings clarify the source of conflicting evidence on the existence of social media bubbles (Barberá et al., 2015; Barberá, 2020; Bakshy et al., 2015). They also converge with recent research that explores the topological effects of confirmation bias in social networks (Sikder et al., 2020), which only require a small group of very active nodes to dominate data in networks. Findings also align with new studies that distinguish between the connectivity effects (high in-degree) and activation effects (high frequency sharing) of users in networks (Saxena and Kumar, 2019). We document statistically significant differences in the frequency ("partisans share more") and in the type of frame elements ("partisans share different") activated by partisan and nonpartisan users in a fully randomized experiment.

Our novel image-based conjoint experiment is designed to test for quantitative and qualitative differences in the frames shared by partisan and nonpartisan respondents. We implement three conjoints with pairs of tweets that rotate the different frame elements: *author*, *text*, *images*, and number of *likes* of paired posts. After exposure, we ask respondents which tweet they are likely to share, allowing the options *both* and *neither*. We also ask which tweet they expect their friends to share; and which tweet they expect to see first on their favorite news show. The design allows us to compare network activation by oneself and expectations of activation by peers. We implement the conjoint experiments in

Argentina, Brazil, and Mexico.

The organization of this article is the following. The first section describes how NAF behavior explains the subjective perception of social media bubbles, echo-chambers, and polarization. The second section revisits alternative models of frame activation in social media and describes the statistical connections between frame activation and the *Friendship Paradox* in social networks (Feld, 1991; Sikder et al., 2020). The third section describes our experimental design and hypotheses, highlighting the difference between activation by users (*self*) and the expected activation by friends (*peers*). The fourth section describes the results of our experiments in Argentina, Brazil, and Mexico. Findings validate three key hypotheses: first, partisan users share *more* content; second, partisan users share different frames than non-partisans; and, third, partisans expect their friends to share partisan content. As a result, partisans' preferences are overrepresented in the *output* data. We conclude with a discussion of why previous studies reported mixed findings when describing social media bubbles and what are promising future extensions of this research.

1 Network Activated Frames, Social Media Bubbles, and Polarization

1.1. Bubbles

Few phenomena are as characteristic of our times as political polarization (Mason, 2018; Iyengar et al., 2012; Abramowitz and Saunders, 2008, Gidron et al., 2019). In the scholarship that developed to explain the causes of polarization, researchers frequently ask whether social media and the emergent digital technologies contributed to heightened levels

of perceived polarization (Lelkes et al., 2017; Stroud, 2010; Settle, 2018; Sunstein, 2018, Bail et al. 2018).

A popular hypothesis that connects social media usage and mass polarization focuses on the potential of new technologies to generate echo chambers or filter bubbles. That is, to deliver content that reinforces existing partisan animosity through motivated reasoning and online sorting. The argument was forcefully advanced by Cass Sustein (2018), who argued that we are more likely to connect with users that consume information we like and users that share our beliefs. The result is *online sorting* and *network homophily*, whereby citizens are exposed to higher doses of pro-attitudinal opinions that reinforce their existing preferences and attitudes. In contrast, counter attitudinal messages are less likely to be observed, as users who do not share our opinions are screened out. In line with a long tradition of deliberative democracy (Habermas, 1991; Mansbridge, 1983; Fishkin, 1991), polarization is a consequence of the lack of ideological diversity that characterizes life in online echo chambers and filter bubbles (Sunstein, 2018; Mason, 2018).

While the argument remains popular, recent research finds little support for the *sorting* model of echo chambers in social media. There is robust empirical evidence that the levels of online segregation detected in early studies (Bakshy et al., 2015; Conover et al., 2011) are not particularly different from offline media consumption (Gentzkow and Shapiro, 2011). Recent studies also show that homophily in networks is limited to interactions related to political events (Barberá et al., 2015; Wojcieszak and Mutz, 2009). Finally, evidence is mounting that online news consumption, at least in the United States, is less segregated than

previously thought, with users actively accessing centrist and high reputation news organizations that do not necessarily align with the user's ideology (Guess et al., 2021). Although homogeneity in social media networks is prevalent, cross-contamination is not infrequent.

Current research studying exposure to political information in social media presents researchers with an interesting puzzle. Most users are embedded in diverse social networks yet they routinely describe subjective perceptions of widespread polarization and high dosages of partisan content. This subjective experience also fits descriptions by experts and policymakers (Barberá, 2020). Previous studies tackled this puzzle by showing that, contrary to more deliberative normative expectations, heterogeneity and exposure to uncivil content in users' networks might actually be one of the drivers of polarization (Bail et al., 2018; Banks et al., 2021; Suhay et al., 2018). However, while it may be true that heterogeneity could increase polarization, the subjective perception of users, experts, and policymakers is not that their networks are very diverse but rather that they are not.

1.2. Content Activation and the Friendship Paradox

We advance an alternative explanation that is compatible with socially heterogeneous yet highly partisan social media experiences. We focus on whether a diverse input content may still yield a highly partisan output. Our experiment shows that a network with a large number of moderate social media users and diverse input content is consistent with a social media experience that includes echo chambers. Instead of focusing on sorting, we consider

differences in the activation of partisan and nonpartisan content. Differences in the sharing behavior of partisans and nonpartisans, we argue, made available to peers. If partisans share *more* framesalter the frequencies of the authorities, texts, images, and endorsements and partisans share *different* frames, their preferences and attitudes will be overrepresented in a social media network.[1]

Perceptions of high ideological congruence belong to the family of phenomena known as the *friendship or class size paradox*, where if there is "any variation in college class sizes, then more students experience the average class size as larger than the mean. They experience a higher average class size than exists for the college because many students experience the large classes, while few students experience the small classes" (Feld, 1991, pp. 1475). Similar mechanisms explain why changes in the relative frequencies of content activated by ideologues heighten the users' subjective perceptions of social media bubbles. As shown by Sikder et al. (2020), once confirmation bias is formally linked to social connectivity it is enough for a "small group of individuals to generate permanent opinion polarization and cascade dynamics" (Sikder et al., 2020, pg. 1). We provide conclusive evidence that this effect will also occur when the sharing rates of partisans and non-partisans differ from each other.

Because content on social media depends fundamentally on the users' decision to propagate messages, to account for the subjective perception of bubbles in a network it is

[1] While we test for the effect of partisanship on sharing, we do not sort out the potential reasons that explain why partisans share *more* and *different* content. An extensive discussion that relates partisanship and dispositional political interest is thoroughly discussed in Prior (2019).

only necessary to show that partisanship and frame activation are positively correlated (Aruguete et al., 2021). That is, proving that, first, (i) partisans share content with a higher frequency than non-partisans, so that the content they prefer is over-represented in observational data. Second, (ii) proving that partisans share content that is different from that of non-partisans. The result will be that individuals in a network will observe larger doses of partisan content. This general result does not depend on how diverse is our network of peers, which explains why it is possible to both have a diverse network of peers and to see partisan content overrepresented in our social media feeds (Aruguete, 2019; Barberá et al., 2015; Barberá, 2020; Bakshy et al., 2015).

Our empirical work confirms both mechanisms: beginning with identical probabilities for all frame elements via a conjoint design that randomizes all content, we show that (i) partisans and ideologues are more likely to share content they agree with; and (ii) the preferred content of partisans and ideologues is different from the content preferred by non-partisans. We confirm these conditions when we analyze: i) sharing (self), and ii) sharing expectations (peers).

Support for the "generalized friendship paradox" is theoretically and empirically relevant (Fotouhi et al., 2014; Jo and Eom, 2014; Feld, 1991; Benevenuto et al., 2016; Eom and Jo, 2014). First, while limited topological sorting in networks is one of the reasons that researchers have challenged the existence of social media bubbles, evidence is overwhelming that users are more likely to share content that is ideologically congruent and to perceive that the content shared by peers is highly partisan (Del Vicario et al., 2016;

Barberá et al., 2015). Frequency differences in the content shared by our friends will result in sharing probabilities that do not reflect the proportions of ideologues among our friends but rather their degree centrality and their sharing behavior (Saxena and Kumar, 2019)

Second, because network activated frames depend on the *frequency* of activation, rather than on the number of users in the population, frame elements will be weighted towards the preferences of the most connected and engaged *local* users (Barberá, 2020). As the density of partisans increases, the content variance will decline locally and "bubble" like frames will heighten perceptions of polarization among our friends. It is not necessary to follow like-minded friends to be exposed to higher doses of like-minded content and to see congruent content coming from different local regions of a network. Conflicting evidence on cross-cutting ideological connections is not inconsistent with observational data that "looks" like a bubble (Bakshy et al., 2015).

Third, our results explain that partisan voters will increasingly perceive that their friends are as partisan as they are. By contrast, independent voters in Argentina, Brazil, and Mexico do not report that their friends share more partisan frames on social media. This is consistent with the central tenets of the *generalized friendship paradox*, with "bubble" like content being more prevalent only among those who share the selected trait (i.e. partisanship).

2 Network Activated Frames

Entman coined the term cascading activation (Entman, 2004) to describe how traditional media organizations render visible only some of the frames proposed by elites, preventing

some content from reaching the public. Cascading activation, as a faulty Rube Goldberg machine, allows only a subset of the falling pieces to activate source content, altering the frequency of the frames observed by readers. In Entman (2004), however, frame elements are never amplified but rather filtered by the traditional media[2]; framing and frame are two sides of the same coin. The former refers to the integral and active process of production, circulation, and reproduction of socially shared and persistent meanings over time (Reese et al., 2001, Pg. 11). The latter is present in the different stages of the communication process. In social media, framing is the result of how content is created and posted by users (production) and how this content is activated by peers (reproduction and circulation). To address the problem of amplification in social networks, Entman and Usher (2018) generalize the concept of activation as a process that produces, distributes, assimilates, and activates information. The new media scenario prompts them to revise the initial model in favor of a Cascading Network Activation model, which describes the characteristics of digitization on the symbolic relations of power between elites, traditional media, and citizens.

The concept of Network Activated Frames (Aruguete and Calvo, 2018; Aruguete, 2019) seeks to update the notion of the integrality of the framing process, taking into account the dynamics of content propagation in a digital media and virtual social networks have a prime

[2] Entman (2004) notes that "The metaphor of the cascade was chosen in part to emphasize that the ability to promote the spread of frames is stratified" (Entman 2004, p. 9). They start in the governments, go through the network of nonadministrative elites and follow their course through the news companies and their texts to stay in the public perception schemes. Entman asks if the frames expressed in the highest stratum of that system do manage to arrive intact to the social base or if, instead, alternative interpretations from the bottom level back up to policymakers to challenge the governmental frame.

role in the circulation of endorsements, texts, and images that structure the social world. The *Network Activated Frames* extends notions of activation in Entman and Usher (2018) to describe the framing effect of frequency changes in content that is amplified by algorithms, users, and the media. Aruguete and Calvo (2018) describe this change in the frequencies of the content shared by users as a "selection effect". Meanwhile, the aggregate frames observed by the users are described as a "compositional effect", with different aggregate interpretations of phenomena in each region of the social media network.

Behavior that amplifies some frame elements rather than others, the result of a higher weight given to cognitive congruence or the result of more attention to an issue, increases the probability of sharing a particular frame element (selection effect). Meanwhile, selective activation of congruent content by social media peers and the accumulation of certain frame elements at a given network location yield locally homogeneous frames, forming what we know as social media bubbles ("composition effect").

In the next section, we describe an experiment to measure the "selection effect" of frame elements by partisans. Observed from the consumption side, the end result is local frames that provide a meaningful interpretation of locally important events, with partisans contributing to local frames at a higher rate than non-partisans (i.e. bubbles).

3 Using Conjoint Experiments to Measure Network Activated Frames

The objective of our conjoint experiments is to theoretically relate *activation*, *framing*, and partisanship in social media. After Hainmueller et al. (2014), conjoint designs have

become a prominent methodological tool across many distinct fields. Conjoint experiments provide treated individuals with two competing profiles with randomized traits (conjoint profiles). After exposure, they ask the subjects to select the profile they prefer or, in our case, the social media post they would like to share.

Different from the traditional conjoint, our experiment adapts this design to compare frame elements that are embedded in social media posts and measure changes in the frequency of the different frame elements. As important, we do not force the selection of one of the two frames, allowing respondents not to share traits. This allows us to observe differences in the activation rate of different frame elements by partisans and non-partisans.

The experiment uses a factorial design that creates on-the-fly tweets. During the survey, each respondent is exposed to pairs of edited tweets created solely for the experiment. The messages replicate news media content on issues such as public security (Mexico and Brazil) and COVID-19 (Argentina). The messages vary on four dimensions: the author of the tweet (endorsement), the text of the message (positive and negative frames), an associated image (partisan, collaborative, and neutral), and high or low numbers of 'likes' and 'retweets' (public support). In the appendix, we present the full sets of frame elements and examples of the paired tweets that are randomly created. While the frame elements and the issues in the conjoints vary by country, the design and questions are identical. Therefore, all three experiments test exactly the same two mechanisms: (i) partisans share content at a higher rate than non-partisans and (ii) the content shared by partisans is different than that of non-partisans.

Image-based conjoint experiments offer several advantages for measuring the connections between framing, social media activation, and partisanship. First, the fully randomized nature of conjoint experiments allows researchers to remove sorting effects that might endogenously contaminate research relying on behavioral social media data. Second, as argued by Hainmueller et al. (2014), conjoint designs allow researchers to manipulate many different features and identify treatment effects simultaneously. Because social media effects can emerge from many factors (author of a tweet, content, social support, among others), the flexibility of this design makes it ideal for understanding media effects. Finally, when incorporated together with real social media images, visual rotations of the conjoints provide a more realistic environment in which participants make decisions. Previous research has shown important gains in ecological validity when experiments provide more realistic environments (Vecchiato and Munger, 2021; Thal, 2020, Horiuch et. al., 2021).

3.1 Conjoint Design

Each of the frame components varies as follows. First, (1) the authors of the tweet randomly display Liberal and Conservative media outlets, creating four possible combinations: Lib-Lib, Lib-Cons, Cons-Lib, Cons-Cons. Second, (2) the text of the tweet offers competing positive and negative attributions of responsibility for the event (COVID-19 in Argentina and security in Brazil and Mexico). Respondents are exposed to one of four possible combinations, introducing small variations to the wording of the positive and negative messages to ensure they are not strictly identical. These small

variations minimize experimental detection by respondents. Third, we (3) randomize images that reinforce or undermine the partisan interpretation of text of the tweets. Three pictures are rotated to ensure that pairs of tweets always display different images: Congruent-Incongruent, Congruent-Placebo, Incongruent-Placebo. Finally, (iv) we randomize the numbers of likes and retweets at the bottom of the message to indicate high or low support by peers: High-High, High-Low, Low-High, Low-Low.

<<Figure 1, Conjoint Example>>

We provide full details in Appendix A of the online SIF. The survey samples have 2,442 respondents in Argentina; 2,417 in Brazil; and 2,373 in Mexico.

3.2 Hypothesis

The experimental design randomly rotates the frame elements and measures differences in sharing behavior among respondents. While the *input* frequencies are uniform (equal probability), the *output* frequencies of the frame elements are modulated by the preferences of the respondents. We expect ideologues and partisans to share more content ("selection effect"). We expect the preferred content of partisans to be overrepresented in the experimental data ("composition effect"). Finally, we expect the content shared by partisans to be different from that of non-partisans (Fotouhi et al., 2014; Jo and Eom, 2014; Feld, 1991; Benevenuto et al., 2016; Eom and Jo, 2014).

The first hypothesis of our study measures whether partisans share more content than non-partisans. If activation (attention) and partisanship are positively correlated, then

content shared on social media will appear to be more polarized than it actually is. The preferences of intense ideologues would be overrepresented in the data and contribute to heightened perceptions of polarization. A test of this finding using observational data was reported by Aruguete et al. (2021).

The literature on affect and polarization shows that partisans and ideologues are unconditionally more motivated to participate in politics and in social media (Mason, 2018; Barberá, 2020; Slothuus and De Vreese, 2010; Guess et al., 2021; Törnberg, 2018). A recent study by Osmundsen et al. (2021) also describes partisan effects in fake news sharing, with larger increases in the likelihood of social media news among respondents that are more attentive to issues raised by their parties. Indeed, motivated reasoning that seeks to validate negative and positive evaluations of political events among partisans not only increases attention to particular types of evidence but will also be more enthusiastic in communicating this information. A recent study of observational social media data in Argentina, Brazil, and the United States by Aruguete et al. (2021) supports that ideology and attention are highly correlated in observational social media data, with the preferred content of ideologues more frequent than the content of non-ideologues. Accordingly, we expect partisanship and social media sharing to be closely connected.

The expected correlation between ideological preferences and attention to issues is predicated on differences in motivated reasoning and hot cognition (Slothuus and De Vreese, 2010; Lelkes et al., 2017), where information that validates existing beliefs is more readily searched and shared by ideologues. If negative and positive evaluations of political events

result in voters seeking and delivering information that is consistent with their preferences, motivated voters will be both more enthusiastic as well as more attuned to particular types of evidence, which will positively correlate ideological beliefs and issue attention (Weaver, 1991). Stronger partisan priming will also result in faster memory retrieval (Kahneman, 2011), which is another marker of *hot cognition* that is expected to increase sharing. Therefore, the hypothesis to be tested states that:

H_1: Partisan users will be unconditionally more issue motivated than non-partisan voters to share cognitively congruent political content.

The first hypothesis, H_1, expects partisan content to be more readily shared in social media and, consequently, over represented in observational data. The second hypothesis connects partisan respondents with frame elements. In effect, bubbles are expected because partisans share more and because they have a distinct taste for the type of content they share. Conservative voters are more likely to share content from conservative newspapers, such as Fox News (USA), La Nación (Argentina), OAntagonista (Brazil), or Reforma (Mexico). As the conjoint experiment guarantees that there is no topological sorting, differences in sharing distinct partisan content could only be explained by differences in the sharing behavior of these attentive partisans. The hypothesis aligns with evidence that explains social media bubbles by changes in the frequency of content shared by partisans (Del Vicario et al., 2016; Barbera and Rivero, 2015). Similar results are shown in signal processing and machine learning, where the amplification of weak signals reduces total variance in what is known as "boosting". Therefore, our second hypothesis:

H_2: Users will share congruent content that aligns politically with the preferences of their co-partisans (in-group cognitive congruence), reducing the stochastic variance in the initial frame elements.

Our final hypothesis is derived from the family of phenomena known as the *friendship or class size paradox*, with an increase in the variance of partisan content resulting in subjective perceptions of partisanship that are larger than its overall frequency. In Aruguete and Calvo (2018) this is described as the "compositional effect" of activation from the viewpoint of the observer. In terms of Feld (Feld, 1991, pp. 1475), the average user experiences more partisan content than the prevalence of partisans. The experimental results align with the formal treatment by Sikder et al. (2020), where it is enough a "small group of individuals to generate permanent opinion polarization and cascade dynamics" (Sikder et al., 2020, pg. 1) once confirmation bias is formally linked to social connectivity. A similar discussion is presented by Saxena & Kumar (2019) when considering the level of activity of a node. They present the question as a thought experiment on an organization that is interested in the value of a highly connected node that is not very active and a less connected node that is very active. They ask whether the best choice to propagate a message is "a node with a higher degree but lower activity level or a node with a lower degree but higher activity level?" (Saxena and Kumar, 2019, pp. 40). In the political arena, partisans should observe higher levels of partisanship among their friends than non-partisans, if their partisan friends are more active. Therefore, our third hypothesis:

H_3: Partisan users expect their friends to share more partisan frames.

Having summarized the theory behind all three hypotheses, we will now describe the experimental design. As explained before, we expect H_1 and H_2 to increase the sharing of partisan content in our experimental design (and in social networks) while H_3 increases the expectations of observing partisan content among our networks of friends.

3.3 Variables

The main dependent variables measure the decision to share each of the paired tweets by a respondent (self) and the expectation that the friends of the respondent will share each of the tweets (friends). For the first question, *self*, the variable takes the value of 1 if the respondent indicates his preference to share a tweet and 0 otherwise. Respondents can share both tweets, tweet 1, tweet 2, or neither.[3] The second variable takes the value of 1 if the respondent expects a friend to share a tweet and zero otherwise.

In addition to our conjoint features, we separate our results between partisans and non-partisans users. We measure partisanship in two different ways. First, we measure the self reported partisan identification for the major parties in Argentina, Brazil, and Mexico. Second, we measure vote choice "if the election were to take place next week", allowing for the option to vote blank. Therefore, we are able to compare both the difference in frequencies among individuals that report a partisan identification and also for individuals that vote the different parties. We consider partisans users who reported prefer/vote for any

[3] A separate question asks which tweet you would be less likely to share, forcing the choice of a single one of those tweets. This would be the traditional design in a conjoint experiment, but forcing all respondents to select one of the two tweets would not allow us to measure the frequency of activation. Therefore, our design allows for both tweets and neither to be shared, allowing a direct measure of the frequency of activation of distinct frame elements

of the political parties listed in our survey, and non-partisans respondents who reported not having a partisan preference, or voting blank in the last presidential election in Argentina, Brazil, and Mexico.

Given the fully randomized nature of our experiment, and proper balance as described in the SIF file, results are conclusive and do not require further controls. However, the supplemental information file presents models that include a variety of controls for readers interested in the effect of socio-demographic covariates on sharing behavior. We added controls for age, gender, income, and education. The effects of these socio-demographic variables vary across countries. As expected, the inclusion of these controls does not alter the direction or significance of the estimates presented here.

4 Results

In this section, we present two different and critical results. First, we show that partisans are more likely to share tweets (self) and that partisans are more likely to expect that their friends will share tweets (friends). Therefore, the first set of results validates H_1 and shows that in experimental data the preferences of partisans are more broadly shared. Second, we present results that show that partisans share different frames than non-partisans H_2 and that they expect their friends to also share partisan frames H_3.

4.1 **Higher Activation: Test of** H_1

In Figure 2 we present results that test for the difference in overall activation by partisans

and non-partisans as well as for party voters and blanc voters. Figure 2(a) reports the likelihood of sharing tweets for partisans and non-partisans in all three countries. Figure 2(b) reports the likelihood of sharing tweets for the voters of parties rather than those that voted blanc. Figure 2(c) reports the expectation that the friends of partisans and non-partisans will share these tweets. Finally, Figure 2(d) reports the expectation that the friends of the different party voters or those who vote blanc will share tweets.

<<Insert Figure 2>>

In all four plots, results show higher rates of sharing among partisans and their friends as well as higher rates of sharing among those respondents who voted for a party and their friends. Approximately 36% of partisans in Argentina indicated their preference to share tweets compared to 28% of non-partisans, a statistically significant increase of 8 points. Similarly, the expectation of content being shared by the friends of partisans is 7 points larger, increasing from 23% to 30%. Differences among voters are even larger, a total of 11 points for self and 9 points for friends.

Results are a bit more modest but also statistically significant for all comparisons in Brazil and Mexico. In Brazil, the increase in sharing is only 2 and 3 points respectively for partisans and their friends. However, the differences are statistically significant. Higher sharing is also observed among party voters, with a 3 point difference for self, and 7 points expected for the party voters' friends. In Mexico, sharing increases are 6 points and 4 points for partisans and their friends, and 3 points and 2 points for party voters and their friends. This last coefficient, the 2 point difference observed among the friends of party voters in

Mexico, is the only one that fails to reach statistical significance.

In appendix C, we present model results regressing our partisanship variables and the decision to share (*self* and *friends*). In addition to the two previous partisanship variables, we also added three more models using ideology extremism (distance between respondents' ideology and the center of the ideology scale) as an explanatory variable. Summary effects in Figure 3 show that the increases in content sharing by partisans are significant and of similar magnitude across all three countries. Similarly, the positive effect of ideological extremism on sharing is quite robust, with comparable effects in all experiments.

<<Insert Figure 3>>

4.2 Congruent Partisan Sharing, H2, and H3

In this section, we present results showing that partisans share different frames than non-partisans and also expect their friends to share partisan frames. To make the presentation easier, we focus only on the variable vote choice to identify partisans in the three countries. Our quantity of interest is the difference in marginal means for every feature in our three conjoint experiments between partisans and non-partisans. We focus on the marginal means, instead of the more heavily used Average Interactive Component Effect (Hainmueller et al., 2014), because these quantities are more appropriate to identify heterogeneous, subgroup effects when dealing with conjoint designs (Leeper et al., 2020). In addition, we separate the results between leftists and conservatives partisans using the vote choice independent variable. This decision allows us also to observe the directional effects

of the frames between distinct partisan groups.

<< Insert Figure 4>>

Figure 4 presents the results of the respondents' decision to share. The point estimates in each figure indicate the difference in sharing rate between leftists/conservatives and non-partisans in Argentina, Brazil, and Mexico. The x-axis contains the features (frame elements) that are embedded in our social media image-based experiment. Positive point estimates show that leftists/conservative respondents have a higher propensity to share one particular frame element averaging across all the other features. This quantity of interest uses the non-partisan groups as a baseline.

All the models show partisans, from the left and right, are more likely to share congruent social media messages when compared to non-partisans. In Argentina, conservative respondents are 5% more likely to share a tweet where the actual argentinean President Fernández (from the left) sends a message crossing-the-isle and signaling to the opposition about a national front to fight the Covid-19 crisis. Meanwhile, the leftist voters are more likely to share both contents, one with the cross-the-isle message but also a message blaming the previous government for the health crises in Argentina.

Similar patterns, when considering only the content of the social media messages, appear in Brazil and Mexico. Conservative Brazilians, who support President Bolsonaro, are more likely to share in-group messages, which call for more punitive security policies to reduce crime in Brazil, and less likely to share messages calling for more welfare policies. The opposite trend appears among leftists voters. Meanwhile, leftist Mexicans, supporters of the

actual Incumbent, show a higher propensity to share a general framing message about the crime issue, and a lower propensity on messages blaming the actual administration for the rise in violence in the country.

Contrary to our expectations, there is lower than expected discrimination between the pro- and anti-government frames shared by conservative respondents in Mexico. Results show that Conservative voters who support the PRI and the PAN share "*more*" of both frames (the anti-government and the cross-the-aisle one). Consequently, while conservative respondents contribute more information to the Mexican network, as expected, they do not necessarily contribute information that increases polarization.

Importantly, the reference groups for all these models are independent, non-partisan voters. Therefore, these differences in the propensity to share show how congruent frames make partisans more active in social media, when compared to independent voters. These robust findings across three different countries provide conclusive experimental evidence for the formation of bubbles from sharing behavior, and explain the over-representation of partisan content on social media.

<<Insert Figure 5>>

We now present results for the respondents' expectations about the sharing behavior of their friends' behavior. Our results provide strong evidence for the NAF behavior on social media. Figure 5 provides a similar interpretation as in figure 4; conjoint features (frame elements) for the three countries are presented in the x-axis and differences in sharing rate (marginal means) are presented on the y-axis with point estimates and confidence

intervals. However, instead of focusing on behavior, figure 4 focuses on respondents' expectations about sharing behavior of their friends regarding each tweet. Positive point estimates in figure 4 indicate leftists/conservatives expect their friends to, on average, share more of a particular frame element than non-partisans expect their friends to do.

Across all three cases, partisan respondents expect higher levels of partisanship among their friends than non-partisans do. Now, instead of looking directly at the content of the conjoint features, let us consider the effect of the feature Header, which shows a more liberal and more conservative news media as the author of the tweet.

In all three cases, partisanship aligns closely with the expectation about which outlet our friend would share. Leftists in Brazil, Argentina and Mexico believe their friends show higher sharing rates for social media messages sent by in-group media outlets, while conservatives, in most cases, have the exact opposite expectation. As before, differences in the marginal means for the contents follow closely the ones discussed in figure 4. In the appendix, we compare estimates between sharing behavior and expectation about the respondents' friends. For the majority of the cases, there are no meaningful statistical differences between the respondents' behavior and what they expect from their friends.

5 Conclusion

How does the sharing behavior of interconnected users frames political events? How do partisans and non-partisans alter the frequencies of the texts, images, and endorsements we observe in social media? This article provides clear experimental evidence that a social

network randomized input frame elements will output local frames that over-represent the preferences of partisan respondents.

In doing so, we provide conclusive evidence that a network with cross-cutting ideological friends will still produce bubbles. Only two conditions are required for this conclusion: partisans sharing at higher rates than non-partisans and sharing different frame elements than non-partisans. The proposed conjoint experiments describe these mechanisms replicating observational findings of network activation (Aruguete and Calvo, 2018; Aruguete, 2019, Aruguete et. al., 2021) in three distinct surveys. The results of this study measure substantially similar partisan effects when analyzing sharing behavior (self) as well as the expectation of activation by peers (friends). Partisans share more content than non-partisans, their preferences are over-represented in the output of our conjoint experiments, and they expect their friends to also be over-represented in social media data.

Our study provides several important contributions. We develop a novel theoretical explanation for the mixed-finding relating the formation of echo chambers in social media and the lack of empirical evidence of users' sorting on social networks and media diets (Barberá et al., 2015; Guess et al., 2021; Bakshy et al., 2015). Instead of focusing on sorting, our theory focuses on how social media bubbles emerge from different propensities of partisan users to share content, and their expectations about homophily on their personal networks. Our results explain heightened perceptions of polarization among social media users, even if user segregation across social media networks is not particularly high.

Second, our novel research design contributes methodologically to future research on

social media effects. We show how to easily combine the methodological advantages of factorial experiments with an image-based implementation that provides high-ecological validity for social media studies. By construction, these designs are more flexible when compared to commonly deployed social media framing experiments, since researchers can manipulate several theoretically relevant features (Hainmueller et al., 2014) and also provide gains considering the ecological validity of survey experiments (Horiuchi et. al., 2020; Vecchiato and Munger, 2021; Thal, 2020). Combined with recent research showing robustness of survey methods to measure sharing behavior on social media (Mosleh et. al., 2020), our design alleviates concerns about external validity of survey experiments.

Third, our study expands the literature on social media, polarization, and the formation of social media bubbles to a comparative perspective. The lack of empirical studies about this topic outside of the US context has long been warned by the scholarship (Barbera, 2020). As noted recently by Mitchelstein and Boczkowski (Mitchelstein and Boczkowski, 2021), the dominance of the Global North on communications and social media studies has pernicious consequences, and in their words: "not only reproduces and reinforces inequalities but also results in inferior scholarship" (pp. 132). To the best of our knowledge, we are the first to implement three similar conjoint experimental designs from a cross-national perspective with a focus on social media filter bubbles and content activation. Our results are robust across the three countries, provide high external validity for our initial hypotheses, and contribute with high-quality, and more diverse empirical evidence for a topic that has received considerable attention in the last years by political communication scholars.

Our results are not unique to social media networks. Decades of neurobiology research show that neural networks encode information by increasing or decreasing neuron's firing rates (Humphries, 2021). Further, while it may be true that "neurons that wire together, fire together", the reverse is not necessarily true. Not all neurons that are wired together fire together. In social networks, an over emphasis on connectivity ("who is in our network") does not necessarily inform on activation ("what is shared").

The results of our experiment show that a set of randomized input frames may still yield partisan output frames (i.e. information "bubbles"). However, it does not provide insight into the subjective experience of a "bubble", how *it feels* to be in a "bubble", nor about peer effects, what do we do when our friends share partisan content. Two promising extensions of our factorial design should bring networks *back in*, modeling how peer effects alter our behavior as described by the integrated behavioral model (Montano & Kasprzyk, 2015) and how peers sharing decisions modify our own sharing behavior, as described by the "intuitive politician" model (Tetlock, 1991). While randomized experiments may tell us how to make bubbles, further research is needed to explore in greater detail the subjective experience of observing bubbles.

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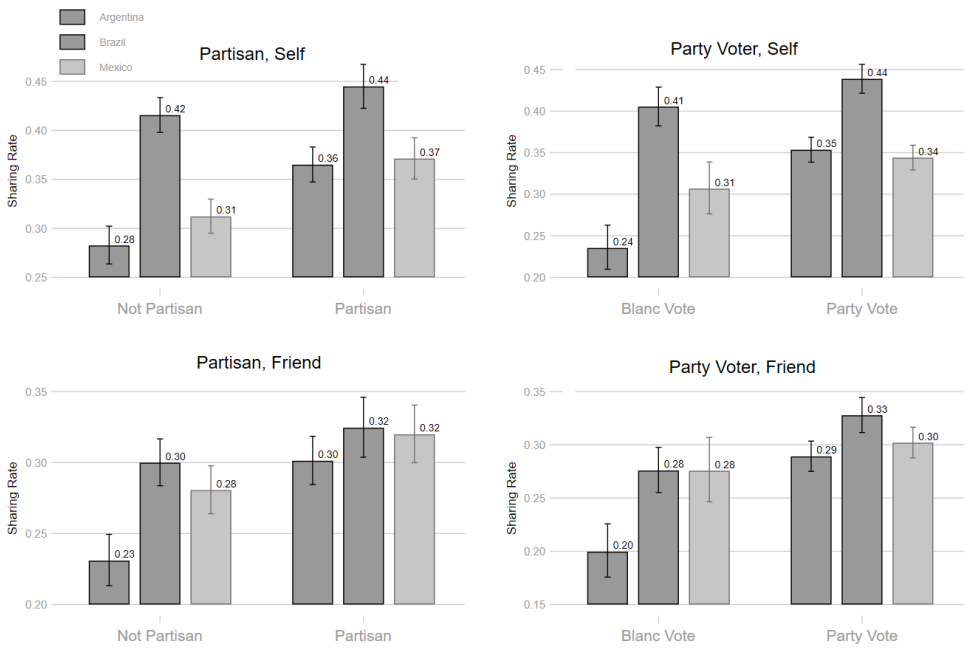
Figure 1 Example of Image-Based Conjoint

***Note*: Figure 1 describes different sample frame elements (left) and how they are on-the-fly combined to produce two possible tweets. Each respondent receives a different combination of frame elements.**

Figure 2 Effect of Partisan and Voter on Sharing



Note: Figure 1(a) describes partisans on self. Figure 1(b) describes partisans on Friends. Figure 1(c) describes party voters themselves. Figure 1(d) describes party voters on friends.

Figure 3: Linear point estimates for Partisanship on sharing

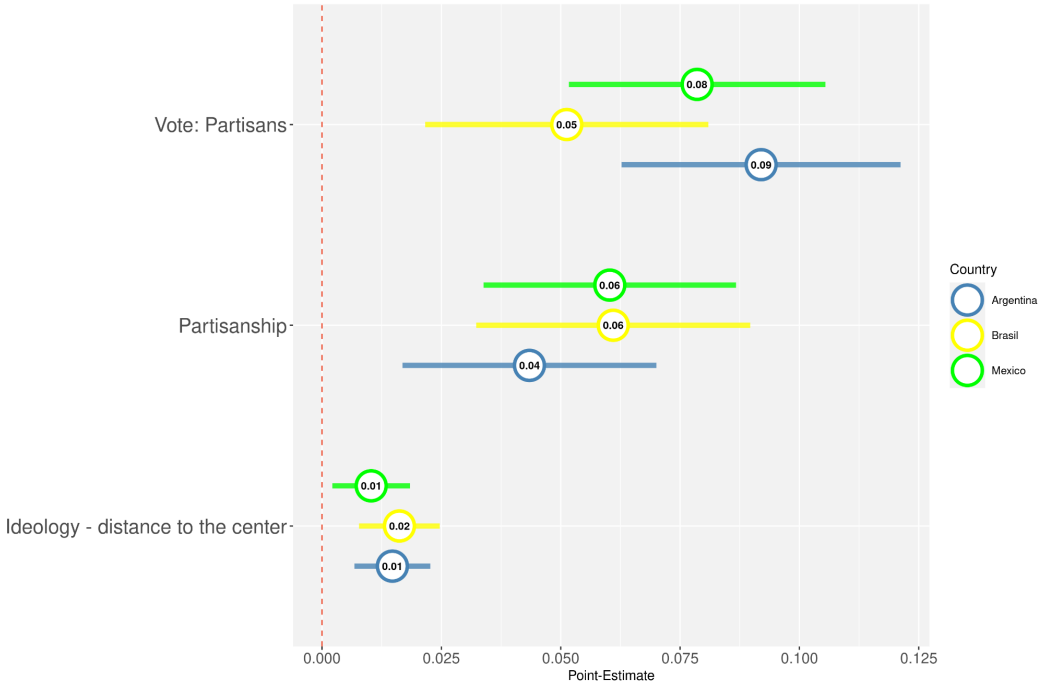
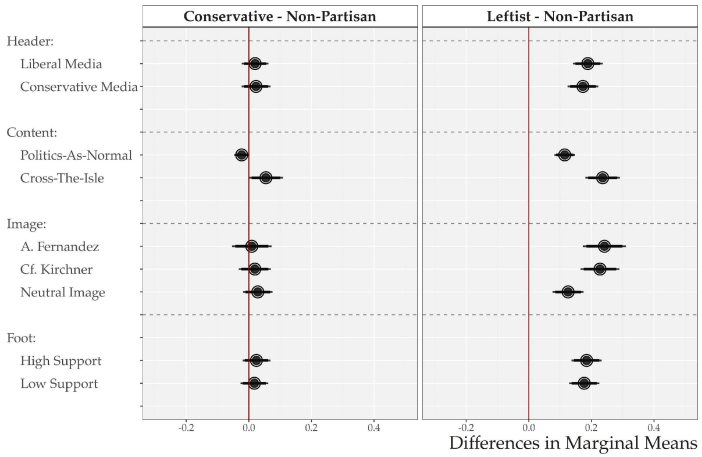
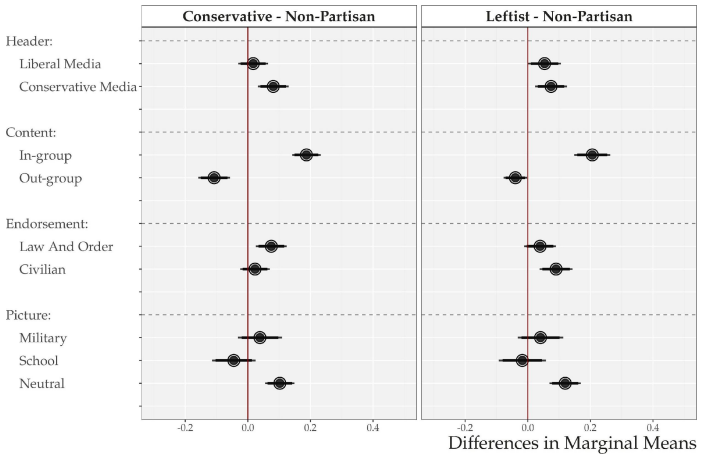


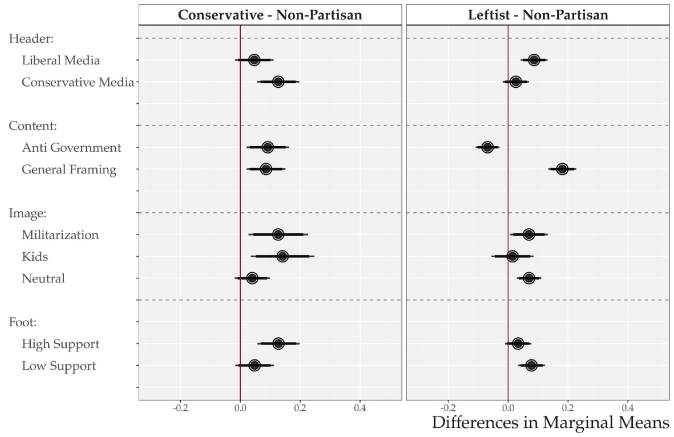
Figure 4 Congruent Partisan Sharing: Network Activated Frames



a) Argentina

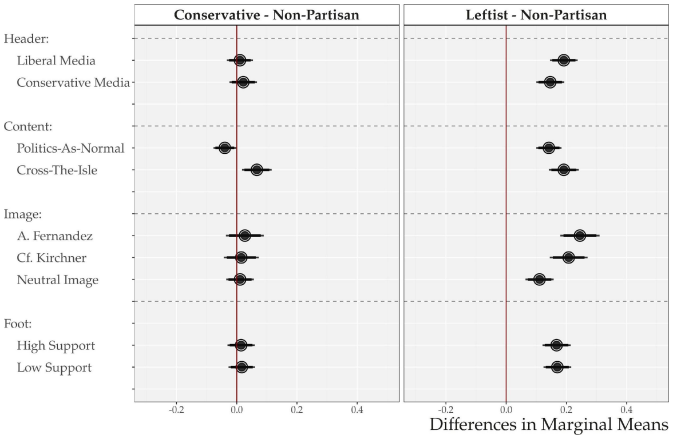


b) Brazil

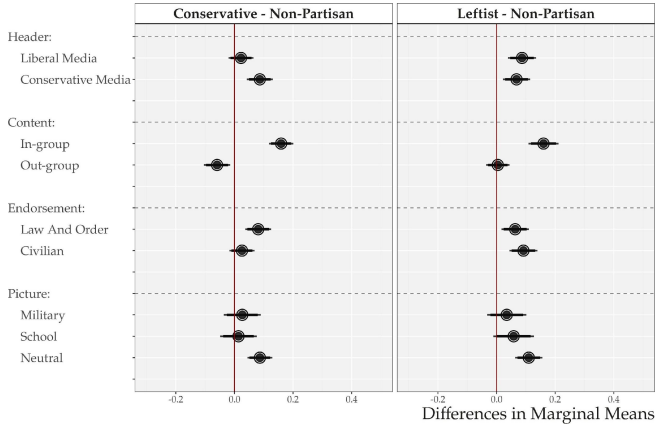


c) Mexico

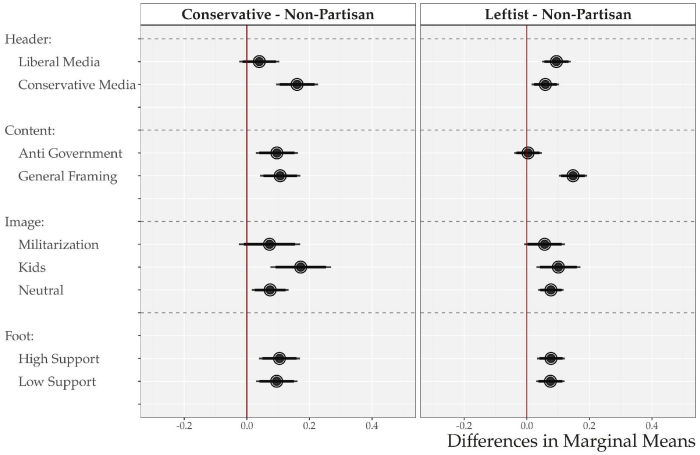
Figure 5 Friends Congruent Sharing: Network Activated Frames



a) Argentina



b) Brazil



c) Mexico