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Empirical Research Paper

Polarization through Social Media?

A Panel data analysis of the German case

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Abstract

This paper investigates the relationship between political social media usage and political polarization in Germany. The study uses data from the German Longitudinal Election Study (GLES), which spans from 2016 to 2021. A fixed effects panel regression model is calculated to measure the correlation between the usage of social media and political extremism. The findings indicate that there is no significant correlation between social media use and polarization. However, political interest plays an more important role in reducing ideological extremes among moderates, but not among those on the ideological extremes. This suggests that other factors may play a more crucial role in driving the increasing polarization.

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Introduction

In 2024, social media usage is very widespread and ever increasing. A variety of platforms are available that are being used by different demographics and for different purposes. For example, TikTok is seen as a platform for the younger generation, while Facebook is seen as a platform for older users. Instagram is popular across all age groups, mostly for social and entertainment purposes, while LinkedIn is primarily used for professional networking. In recent years, there has been an ongoing debate about the impact of the increasing use of social media on political opinions, debates, and polarization due to numerous reasons and trends, which are highly interesting for political science: First, an increasing number of people get most of their political information from social media, while the consumption of print newspapers and classic TV-news is steadily decreasing (C. Lee, Shin, and Hong 2018). Second, with the presidency of Donald Trump, the Brexit-referendum, and the rise of right-wing populist parties across Europe, there have been debates about the spread of fake news, misinformation, and hate speech on social media and how this might increase political polarization. Third, phenomena such as filter bubbles or echo chambers have been widely discussed and are suspected to increase polarization and radicalization of both sides of the political spectrum. Fourth, a general increase in polarization is observed by most scholars occupied with this area of research.

Our goal in this paper is to empirically examine the relationship between active as well as passive political social media usage and political polarization by testing the impact personal political social media usage has on the left-right self-assessment over time. To assess this relationship, we use panel data gathered from the German Longitudinal Election Study (GLES), which spans from 2016 to 2021 and includes information on a total of 37'558 German citizens who are entitled to vote. We chose Germany as our country of interest because it is currently characterized by shifting party dynamics, embodied by the low approval rate of the current government, the rising approval for the right-wing populist AfD, and the newly founded left-wing populist BSW (Handelsblatt 2024). Scandals surrounding the AfD, large protests against right-wing extremism and the results of the recent European parliamentary elections also point towards increasing polarization in Germany. Additionally, most of the research on the impact of social media usage on political polarization focuses on the United States (Kubin and Von Sikorski 2021), and to our knowledge, there is currently only one study specifically addressing Germany (Knobloch-Westernwick et al. 2015). Therefore, Germany presents a very intriguing case study. The research on social media usage and polarization also continuously produces mixed results (Urman 2020). This indicates a need for further clarification of their relationship

in different national contexts. Another problem in this area of research is that social media platforms are subject to rapid changes, which means that: “high quality studies are often obsolete by the time they are published.” (Tucker et al. 2018, 12). The same holds true for political developments that may contribute to polarization independent of social media, for example, emerging crises or newly founded or dissolved political parties, making it necessary to reevaluate the findings of older research. Therefore, our paper fills a gap in the research and might add valuable information to the ongoing debate about the degree to which political social media usage influences political polarization over time. In order to streamline our research aim, we formulate the following research question:

How has the use of social media influenced the political polarization of German voters over time?

The paper is structured as follows: We will begin with a literature review concerning social media, political polarization, and the relationship between those two variables. Next, we will present the statistical methods used. We opted for a fixed effects panel regression using the panel structure of the dataset to our advantage. Then we will discuss our results, which show no significant polarizing effect of political social media usage. Lastly, we explain the limitations of our study and present some directions for further research.

Literature Review

Social media usage

Social media usage has steadily increased over the last years in Germany (Koch 2023). Approximately 81,4 % of the German population uses social media, although this number does not necessarily represent “unique individuals” (Kemp 2024). If messenger services are counted, then WhatsApp is by far the most popular platform (Koch 2023). When measuring the impact social media use has on polarization, an argument can be made that messenger services should not be counted since people, for the most part, interact only with people they already know and there are no public discussions on there. Of course, there is the ability to discuss politics, and share political information, but it is certainly a different kind of interaction than for example on Twitter, which is used by many politicians, parties, and NGO’s and is known for heated political debates taking place between strangers. If the messenger services are not counted, Instagram is by far the most popular social media platform in Germany, followed by Facebook and TikTok (Koch 2023). Most social media platforms have seen an increase in users in Germany in 2024 (Kemp 2024). The platforms are used by different demographics, with TikTok being especially

popular among young people and Facebook among older people (Koch 2023). Men and women use social media approximately on balance, with the exceptions of Pinterest being used more by women and Twitter and LinkedIn being used more by men. Another important distinction is between active and passive use of social media, whereby active use means liking, commenting, sharing, or posting content, and passive use just consuming content (Gainous, Abbott, and Wagner 2021; Verduyn et al. 2017). To our knowledge, there is no conclusive data on how many people use social media actively or only passively in Germany. In our study, we focus on active as well as passive use since our dataset allows us to distinguish between the two. The other distinction that is essential for our research paper is between political and non-political social media use. In our research paper, we will focus on political social media use. Political social media usage has increased generally, leading some researchers to speak about an “explosion of online political groups and activism” (Papacharissi 2019, 43).

We expect this trend to also hold true in the case of Germany. Therefore, our first subhypothesis states:

H1a: Political social media use has increased over time.

Our dataset allows us to see how many respondents are using social media to inform themselves about politics, although the question only asks on how many days of the past week the respondent has seen or read political content on social media and not if they actively searched for it, if this is their main source of political information, or how much of their social media usage relates to political topics.

One consequence of the fact that political debates nowadays often take place online rather than in real-world settings is the creation of so-called echo chambers, whereby people expose themselves only to content that is in line with what they already think and confirms their worldview (Sunstein 2001). This phenomenon is described as selective exposure, which is being done to reduce stress induced by cognitive dissonance, the uncomfortable feeling people get when confronted with mutually exclusive information and belief systems (Festinger 1957; Stroud 2010). The prevalence of online echo chambers, therefore, can lead to radicalization, polarization, and so called “cyberbalkanization” (Chan, Chow, and Fu 2019). This trend might also be reinforced by the design and algorithms of these platforms, that show people content based on what they already watched, read, or liked, preventing them from seeing other points of view (Berman and Katona 2016).

Political Polarization

Our dependent variable, political polarization, can be conceptualized in different ways: The most researched type is affective polarization, which is defined as: “[T]he tendency of partisans to dislike, distrust, and avoid interacting with those from the other party.” (Matthes et al. 2023, 2; see also: Shanto Iyengar et al. 2012). Another type is ideological polarization, which means that people differ strongly in their ideological convictions and are increasingly drifting away from the center to the poles on both sides (Dalton 1987; Jones 2002). Other studies have identified two additional types of polarization. The first one being “interactional polarization”, defined as: “[A] process whereby participants in a debate increasingly interact with likeminded individuals, while disengaging from interactions with others who hold opposing viewpoints” (Yarchi, Baden, and Kligler-Vilenchik 2021, 101). The second one being “positional polarization”, which means “increases in antagonistic and extreme political preferences” (Yarchi, Baden, and Kligler-Vilenchik 2021, 102). There is also the distinction between viewing political polarization as a state or a process: “Polarization as a state refers to the extent to which opinions on an issue are opposed in relation to some theoretical maximum. Polarization as a process refers to the increase in such opposition over time” (DiMaggio, Evans, and Bryson 1996, 693). In this paper, we will focus on ideological or positional polarization as a process. Most studies measuring ideological polarization apply the same method that we do: Likert scales where respondents can report how left- or right-leaning they are (Kubin and Von Sikorski 2021, 196).

Just like social media use, political polarization has also increased in recent years across several countries (Abramowitz and Saunders 2008; Gidron, Adams, and Horne 2019; Hare and Poole 2014; Iyengar and Westwood 2015; C. Lee, Shin, and Hong 2018). Most research on polarization focuses on the United States, where a sharp increase in polarization has been observed since the 2016 election and the following presidency of Donald Trump (Iyengar et al. 2019; Matthes et al. 2023). According to numerous researchers, polarization has increased among people who are not politically active (Frimer, Skitka, and Motyl 2017), as well as among elites (Dalton 1987) and politicians, who quite often actively try to promote polarization to win elections (Boulianne, Koc-Michalska, and Bimber 2020; Hare and Poole 2014). The question of whether men or women show higher levels of political polarization has not been thoroughly researched, except for the study by Ondercin & Lizotte (2021), who concluded, that women show higher degrees of affective polarization than men. Regarding age, Dalton (1987) was able to show that younger elites are more polarized than older ones. Although he added the caveat

that “[t]he significance of increasing ideological polarization among younger elites depends on whether this pattern reflects generational or life cycle effects” (Dalton 1987, 993). However, this study only considered political elites and therefore cannot give us a definite answer if younger or older cohorts are the main drivers of political polarization. Other researchers were able to demonstrate that polarization increased more among people aged 65 years or older than among people aged 18 to 39 (Boxell, Gentzkow, and Shapiro 2017).

In the case of Germany, researchers found “evidence on a confirmation bias in selective exposure to political information” (Knobloch-Westerwick et al. 2015, 505). Although, this effect was much weaker when compared to American respondents. Aleksandra Urman (2020) showed in an analysis of polarization levels from 16 different democratic countries, that Germany displayed comparatively low levels of political polarization (Urman 2020, 19). However, since 2020, there have been multiple developments that might have increased political polarization in Germany. First, Schmid and colleagues (2023) suggest that the COVID-19 pandemic and the preventive measures taken to reduce its impacts may have further increased polarization. Second, the German party landscape saw a sharp increase in the vote shares of populist challenger parties, which was confirmed in the recent elections of the European Parliament, where AfD and BSW combined gained 11,1 % and the governing parties combined lost 10,7 % (European Parliament 2024). In the beginning of 2024, due to scandals concerning the AfD, multiple large demonstrations against right-wing extremism took place, sometimes demanding to ban the AfD, which suggests that polarization is indeed increasing in Germany. In line with these recent developments, we formulate our second subhypothesis:

H1b: Political polarization has increased over time.

The Relationship between social media usage and political polarization

There is a vast body of literature concerning the relationship between social media usage and political polarization, producing rather inconclusive evidence. Some studies have provided evidence that social media usage increases polarization (Boulianne, Koc-Michalska, and Bimber 2020; Cho et al. 2018; Gruzd and Roy 2014; Johnson, Kaye, and Lee 2017; Levendusky 2013). Other studies even find that social media usage has a depolarizing effect (Barberá 2014; Beam, Hutchens, and Hmielowski 2018; Boxell, Gentzkow, and Shapiro 2017; Kubin et al. 2021). Other research has found no evidence for a relationship between social media usage and polarization (Di Tella 2021; Kubin and Von Sikorski 2021; C. Lee, Shin, and Hong 2018;

Nordbrandt 2023; Urman 2020; Valenzuela, Bachmann, and Bargsted 2021; Yarchi, Baden, and Kligler-Vilenchik 2021). Therefore, we formulate our hypotheses as follows:

H0: There is no clear link between individual political social media use and political polarization.

H1: Individual political social media use increases political polarization.

As noted above, the question of whether social media use increases polarization is closely linked to the existence of echo chambers. Selective exposure to pro-attitudinal content has been quite consistently shown to increase ideological as well as affective polarization (Kim 2015; Knobloch-Westerwick et al. 2015). Some research was able to demonstrate that echo chambers are a growing phenomenon that contributes to polarization (Chan, Chow, and Fu 2019; Conover et al. 2021; Garimella et al. 2018; Levendusky 2013; Matuszewski and Szabó 2019; Quattrociocchi, Scala, and Sunstein 2016). Other studies however, showed that not many people are in echo chambers and that this problem might be overstated (Bakshy, Messing, and Adamic 2015; Dubois and Blank 2018; Garrett 2013; Yarchi, Baden, and Kligler-Vilenchik 2021). One study, for example, was able to prove, that many people also consume political information and have friends from the opposing side of the political spectrum on social media and are therefore voluntarily or involuntarily regularly exposed to counter-attitudinal political information (Bakshy, Messing, and Adamic 2015). The theory of echo chambers would suggest that exposure to counter-attitudinal political information decreases polarization, and several studies were able to confirm this (Kim 2015; Marchal 2022). Other researchers, however, found evidence that exposure to counter-attitudinal political information might even increase polarization (Bail et al. 2018; Di Tella 2021; Kim 2019). The reason that this research continuously produces mixed results might be “that the relationship between social media and political polarization is complex and likely heterogeneous” (Nordbrandt 2023, 3393). Or, as Aleksandra Urman (2020, 9) notes: “Contextual differences are the key to answering the question of why previous studies on polarization on social media have found very different results.” One such contextual difference is the political system. There is evidence that polarization is generally stronger in two party systems than in multi-party systems. Other important contextual differences are the media landscape and the preexisting levels of polarization in the country of interest. Most research concerns the U.S., which has a two-party system, a highly partisan media landscape, and rather high levels of preexisting polarization (Kubin and Von Sikorski 2021; Urman 2020). The findings made in an American context can

therefore hardly be generalized to other countries with a multiparty system, a less partisan media landscape, and lower levels of preexisting polarization, as is the case for Germany. Another contextual difference between research on this subject are the users who are being studied. According to Aleksandra Urman (2020, 10):

“The studies that did not find strong evidence of polarisation on SNSs [social networking sites], in contrast, took into account less politicised users and topics and not just political partisans or highly politically engaged users, as in those studies that found polarisation on social media[.]”

When it comes to active and passive users, Johnson and colleagues (2017) were able to show that what drives polarization seems to be not what users see, but what they choose to share on social media. This suggests that active political social media usage leads to higher degrees of polarization. Therefore, our second hypothesis states:

H2: Individuals with active political social media usage are more polarized than individuals with passive political social media usage.

Another important difference is the type of polarization being studied. For example, Allcott and colleagues (2020) were able to show, that the deactivation of respondents Facebook accounts reduced their ideological, but not their affective polarization. Another important reason for differing results is the type of content users watch, read, or share that is being studied. Banks and colleagues (2021) showed that negative content increases polarization. Also, the way in which users engage in discussions leads to different results: Kim and Kim (2019) demonstrated that incivil content polarizes more than civil content. Rathje and colleagues (2021) showed that animosity generates more engagement on Twitter. Hong and Kim (2016) revealed that ideologically polarized content posted by politicians generates more attention. Hasell & Weeks (2016) showed that the consumption of polarized, pro-attitudinal content creates anger in users, which motivates them to share political information on social media. Lastly, also the platforms that are being studied can make quite a big difference in the results that are generated in the process. A quite large part of the research focuses on Twitter or Facebook (Urman 2020). Marozzo & Bessi (2018) were able to demonstrate that Twitter might be more polarized than other social media platforms because the tweets they studied became more affectively and ideologically polarized over time. Other studies also take messenger services like WhatsApp into account and find a lower impact on polarization (S. Lee, Rojas, and Yamamoto 2022).

These differences can explain national variations and prove that the relationship between social media use and political polarization is not a unified phenomenon. This indicates that more research is needed to accurately assess the relationship between these two variables in different contexts.

Method and Data

In order to make predictions on the polarization of individuals, this study uses panel data. We opted for the German Longitudinal Election Study (GLES), published in 2023 (GLES 2023). This panel election study contains 21 waves, which were held between 2016 and 2021, in Germany. The entire dataset contains information on 37'558 German citizens who are entitled to vote. The data collection methods used included various modes, including self-administered questionnaires distributed via web-based platforms (Computer-Assisted Web Interviewing, CAWI), paper-based self-administered questionnaires and computer-assisted personal interviews (CAPI/CAMI).

The operationalization of political polarization is achieved through the utilization of the left-right self-assessment variable, which is coded on a scale from 1 (left) to 11 (right). This variable is recoded to a polarization variable, which ranges from 0 to 5. Values of 1 and 11, which correspond to the far left and right ends of the spectrum, respectively, are assigned a polarization value of 5. The value 6, which represents the middle of the political spectrum, is assigned a polarization value of 0. The remaining values on the left-right scale are recoded accordingly. This allows for the analysis of the entire sample to determine the polarizing effect of political social media usage, regardless of whether the polarization occurs on the left or right.

In terms of measuring political social media use, this dataset provides information on a number of interesting variables. The most basic, but also the most relevant, question in the questionnaire asks respondents how many days in the last week they have read or seen political social media posts. This question serves as an operationalization of the individual political social media usage variable.

Furthermore, the data also includes information on respondents' political online participation. They were asked on how many days in the last week they commented or liked a political post, shared a political post and posted something political themselves. We aggregated these three categories by adding them to receive an index operationalizing active and passive social media

usage. Low scores on this index signify a rather passive social media usage, whereas high scores equal a more active social media usage. To test, if this aggregation is allowed and reasonable, we calculated the Cronbach's alpha reliability score of the three items, which turned out to be 0.88. This is a rather high score and means the three questions measure the same construct and the aggregation is permitted.

Unfortunately, the GLES panel dataset did not use the same questions in every wave. Our two main questions of interest – political social media usage and left-right self-assessment – were only asked in 3 waves in conjunction with one another. This limited our dataset severely: After tidying the dataset and excluding missing values we were left with 2'247 units with three (one for every wave) observations each. The three waves in question are wave 4, 7 and 19 carried out in June 2019, September 2019 and September 2021 respectively. For data handling reasons all three waves were classified as being carried out on the first of each month even though this is not entirely accurate.

We measure the correlation between political social media use and polarization using a panel regression analysis. This approach allows us to both quantify the effect and draw conclusions about the significance of our hypothesized effect. In this regression analysis, the use of political social media is considered as the independent variable, while political polarization and the active online participation represent our dependent variables. Several control variables were included in the different panel regression models, most importantly political interest (coded from 1 “very strong” to 5 “no interest at all”) but also age, gender and education. The choice of control variables relied on similar literature and their approaches. Unfortunately, in the publicly available dataset the birthyear variable, which would have been used to calculate the age of the respondents, was only available until 1955 for reasons of data protection. We contacted GESIS, who carries out the survey, to request access but were denied. As people with birthyear 1955 and lower made up a significant amount of our sample, we could not just exclude them. Therefore, we categorized the dataset in 6 birthyear groups (1955 and earlier, 1956 – 1964, 1965 – 1973, 1974 – 1982, 1983 – 1991 and 1992 – 2000) and used this as an age variable operationalization.

Regarding the panel regression we ran several different models. First, a pooled ordinary least square (POLS) was calculated. This is basically a usual OLS model adapted to time-series data. Due to the ignorance of the longitudinal dimension of the dataset, we decided to switch to a

more sophisticated model and fit a fixed and random effects panel regression model. Also, we conducted a Breusch-Pagan heteroscedasticity test, which turned out to be highly significant indicating the occurrence of heteroscedasticity in our data.

As a second step we calculated a fixed effects panel regression model as well as a random effects panel regression model. To select one of the models we conducted a Hausman test, which was highly significant implying that the fixed effects model is to be preferred. Therefore, we only report the fixed effects model in our results section – once without and once with control variables. As the fixed effects model does not consider time invariant variables some of our before mentioned control variables such as gender, education and birthyear category are not included in the models. To account for the panel structure and the occurrence of heteroscedasticity clustered and robust standard errors were calculated and are reported in the regression tables in the results section.

Lastly, we divided the sample in three different subgroups based on the initial score in the left-right self-assessment to analyze the differences of political social media usage on polarization. Subjects with an initial score of 1 to 5 were classified in a left subgroup, people with a score of 6 were grouped in a middle subgroup and the rest (7 – 11 scores) were classified as right. The same procedure as mentioned above was carried out to find the best fitting model, again leading to a fixed effects panel regression model for all three subgroups.

Results

Before jumping into the main results of our analysis, we first present some statistics on the data we have used in this study. We have collected and analyzed data of 2'107 individuals, that have participated in the GLES questionnaire. Looking at the political social media usage first, we observe, that about half of the participants answered, that they use social media to inform themselves on politics, on zero days a week. We can observe a minor increase of political social media usage over the three waves increasing from 2.18 to 2.33, although it has to be said that this is far from being statistically significant as this change lies inside the standard deviations with a good amount of room left. Looking at the histograms indicating the social media usage in days per week (Figure 1), there is not much change happening over this time period. One interesting observation that can be carefully noted is, that the percentage of heavy users (every day of the week) has slightly increased from 2017 to 2021.

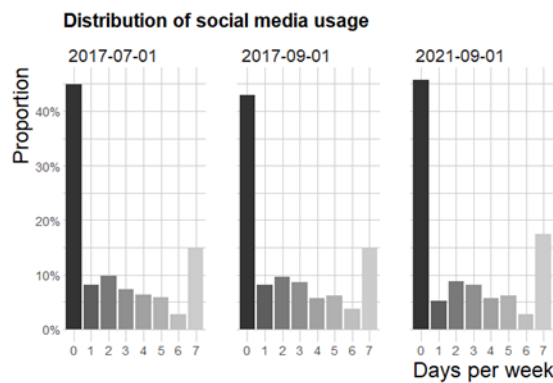


Figure 1 Distribution of social media usage (own illustration)

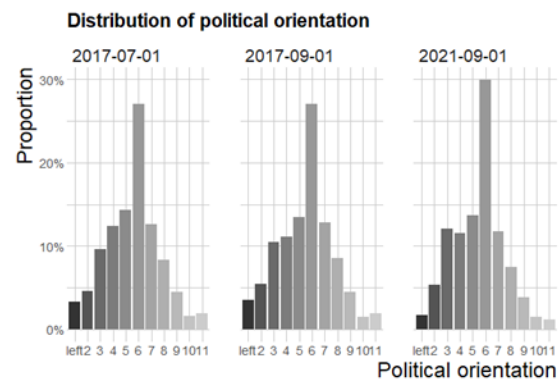


Figure 2 Distribution of political orientation (own illustration)

Looking at the data used in our dependent variable, the left-right self-assessment measured on a 1 (left) to 11 (right) Likert-scale (Figure 2), we can neither observe any significant changes.

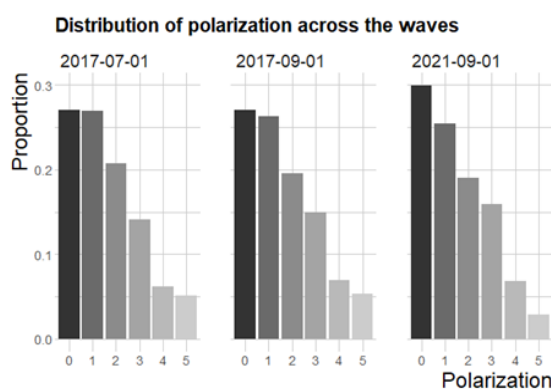


Figure 2 Distribution of polarization (own illustration)

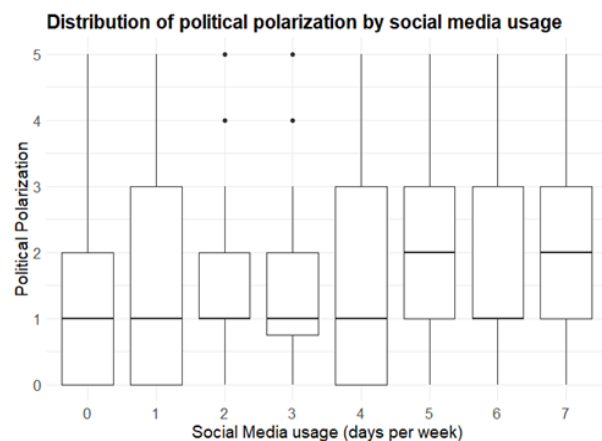


Figure 1 Distribution of polarization by social media usage (own illustration)

The one observation, which could be interesting, is that less people have assessed themselves on the extremes and more have assessed themselves in the middle of the political left-right spectrum. This effect, however, does not go beyond a observation of descriptive statistics.

On the basis of this item, we formed our dependent variable, as introduced earlier in this paper. In this variable we observe a drop of the mean value of political polarization by about seven percentage points, from the second to the third wave. The interpretation of Figure 3 is reluctant, as it behaves the same as the distribution in Figure 2. It gets more interesting and closer to the main analysis of this study, if we look at Figure 4. This boxplot gives us a first glance at a possible correlation between political polarization and social media usage. Notably, the medians and the lower quartiles shift up on the political polarization scale, as social media usage increases. This effect, however, is as all the other effects observed in the descriptive statistics, not significant at all and can only present a first idea, of what the empirical results could look like, rather than leading to conclusions on their own.

Table 1: Panel Regression Model with fixed effects of social media usage on political polarization (own calculations)

	<i>Dependent variable:</i>	
	Polarization- without controls	with controls
soc_med_pol	-0.007 -0.008	-0.008 -0.008
index_active_online_part	-0.0002 -0.006	-0.001 -0.006
pol_interest		-0.046 -0.029
Observations	6,741	6,741
R ²	0.0002	0.001
Adjusted R ²	-0.5	-0.5
F Statistic	0.494 (df = 2; 4492)	1.205 (df = 3; 4491)

Note:

* p<0.1; ** p<0.05; *** p<0.01

With that said, we go ahead and present our empirical results. The relationship between social media use and extremism is investigated using fixed effects panel regression models. The analysis presented in this paper consist of two models. The first model (Table 1) is further split into two sections: one without control variables and another with control variables. The model

without control variables reveals that the coefficient for social media usage on political polarization (denoted as "soc_med_pol") is -0.007, with a standard error of -0.008. This suggests that, in the absence of other controlled variables, social media use does not significantly influence extremism. Turning to the model with control variables, we incorporate additional variables. Notably, political interest and active online participation. As the variable political interest increases, extremism does not change significantly. Furthermore, active participation in online platforms does not significantly impact extremism. The sample size comprises 6,741 observations, and both models exhibit very low R-squared values. It is important to recognize that fixed effects models inherently yield lower R-squared values compared to cross-sectional analyses due to the removal of within-entity variation.

Table 2: Panel Regression Models with fixed effects of social media usage on political polarization with subsamples (own calculations)

	<i>Dependent variable:</i>		
	polarization left subsample	middle subsample	right subsample
soc_med_pol	-0.008 -0.012	0.007 -0.012	-0.019 -0.015
index_active_online_part	-0.003 -0.008	-0.009 -0.013	0.008 -0.011
pol_interest	-0.015 -0.045	-0.137*** -0.049	-0.011 -0.058
Observations	2,973	1,824	1,944
R ²	0.001	0.007	0.002
Adjusted R ²	-0.501	-0.492	-0.5
F Statistic	0.379 (df = 3; 1979)	2.902** (df = 3; 1213)	0.729 (df = 3; 1293)

Note: *p<0.1; **p<0.05; ***p<0.01

The second model (Table 2) indicates that social media usage does not significantly influence political polarization across all subsamples, in line with the results of the first model. Notably, political interest significantly decreases polarization only within the middle subsample (coefficient: -0.137, $p < 0.01$), suggesting that lowered political engagement mitigates polarization primarily among moderates. The interpretation of the variable political interest can

be counter-intuitive, as the scale ranges from 1 (high political interest) to 5 (no political interest).

The initial model (Table 1) demonstrates that social media usage does not have a significant effect on political polarization, both with and without control variables. This indicates that social media alone does not drive extremism. However, the second model (Table 2), which divides the sample into three subsamples based on political orientation, reveals a more nuanced finding. The political interest variable is found to significantly reduce polarization only in the middle subsample (coefficient: -0.137, $p < 0.01$). This indicates that while social media usage does not contribute to polarization, political interest plays a role in reducing polarization among moderates, but not among those on the ideological extremes. However, realistically it is not very meaningful to analyze the effect on polarization of centrist voters.

Based on the information we found in the literature, we formulated two subhypotheses, to test whether our data fits the expected trends. For *H1a: Political social media use has increased over time*, we want to test, if our data matches the observations, that Papacharissi made (2019, 43). In our data we do not find any significant changes to the usage of political social media, which is presented in Figure 1. Therefore, we must deny our first subhypotheses, testing the fit of our data. The second subhypotheses we tested, was *H1b: Political polarization has increased over time*. Given that the share of people, that have ranked the maximum of 5 on our polarization scale, have decreased with time, we must also deny our second subhypotheses. With the denial of our two subhypotheses, we have a sample in our dataset, that behaves against expectations for both dimensions theorized in the literature. Given that the data for both our model variables do not behave as expected, it can be no surprise, that we do not find any positive, leave alone significant effects of political social media use on political polarization. Therefore, we accept our null hypotheses *H0: There is no clear link between individual political social media use and political polarization*. In our second hypotheses, we differentiate between active and passive social media use *H2: Individuals with active political social media usage are more polarized than individuals with passive political social media usage*. It is not surprising, that we could not find support for this hypothesis either, as none of the other hypotheses formulated have found support in our data.

It is important to note, that we do not stand alone in the research field with our results. As Nordbrandt (2023, 3393) has been cited before: “[...] the relationship between social media and

political polarization is complex and likely heterogeneous.”. Thus, our results do not present an outlier in the research field, but they lie in the incredibly broad spectrum of results presented by different scholars (Boulianne, Koc-Michalska, and Bimber 2020; Di Tella 2021; Kubin et al. 2021; Kubin and Von Sikorski 2021; Urman 2020; Valenzuela, Bachmann, and Bargsted 2021; Yarchi, Baden, and Kligler-Vilenchik 2021). That said, our results are in line with the results that have found no evidence for a relationship between social media usage and polarization, as presented before (Di Tella 2021; Kubin and Von Sikorski 2021; C. Lee, Shin, and Hong 2018; Nordbrandt 2023; Urman 2020; Valenzuela, Bachmann, and Bargsted 2021; Yarchi, Baden, and Kligler-Vilenchik 2021).

Discussion

This paper is subject to several limitations and problems, which will be discussed in this section. Firstly, the results – that political social media usage does not affect polarization – cannot be generalized. The findings represent a preliminary account of the situation in Germany and offer initial insights into the mechanisms and effects of political social media usage on political polarization, particularly in Germany. Consequently, the external validity of this paper is limited. Nevertheless, it has a robust internal validity, because the operationalization of the variables – notably the left-right self-assessment and the polarization measurement – are effective estimators of the two measured constructs. The sole point of criticism is, that the measurement of political social media usage in terms of the number of days per week is not as accurate as it could be. This is because the number of days per week allows only limited conclusions to be drawn about the total time spent consuming political social media content.

Secondly, the utilized dataset lacks some features and thereby presented significant challenges during the analysis process. On the one hand, a broader number of waves, where both questions of interest were retrieved, with a more even distribution across time in the dataset would have been beneficial. The available dataset with three waves with essentially one gap between them unfortunately limits the significance of our results severely. The analysis would have benefited from the inclusion of a more extensive panel dataset with a more even distribution of waves. On the other hand, the inaccessibility of the age variable respective the birthyear variable also constrained the analysis as age could have been a crucial variable to implement in the regression models. In addition, it is uncertain, if all necessary control variables were included in the

regression models as the low R-squared value raises questions regarding the quality of the models.

Lastly, there are different methodological approaches and regression models, which could have been used to differently analyze the panel data. For example, first and second differences models or fixed effects individual slopes model could have been applied. Because of a lack in experience using these models and for time limitations reasons, we restricted our analysis to the POLS, random and fixed effects panel regression models. The mentioned models could serve as a starting point for further research.

Conclusion

This study used a fixed effects panel regression model to measure the relationship between the utilization of social media and political polarization. The study uses data from the German Longitudinal Election Study (GLES) and analyses three waves conducted in 2017 and 2021. The findings indicate that there is no correlation between the usage of social media and political polarization, despite its growing popularity as a platform for political discourse. This observation stays consistent for all of our model specifications, regardless of the presence or absence of control variables, and for the left, middle, and right political subgroups. The study highlights methodological limitations that may limit the generalizability of the findings, such as non-random sampling and other constraints associated with the dataset, as highlighted before.

The research question presented in the introduction of this paper examines the correlation between the usage of social media and political polarization. Our results suggest that there is no significant impact of social media usage on the political polarization of German voters over this period of time. The results align with the research conducted by Urman (2020), Yarchi et al. (2021), and Kubin and von Sikorski (2021) and other studies, which also concluded that there is no significant evidence supporting a connection between social media usage and increasing political polarization.

Despite claims made by some scholars that social media fosters political polarization through echo chambers and filter bubbles, this study's results suggest otherwise, backed by research (e.g. Chan, Chow, and Fu 2019; Conover et al. 2021; Garimella et al. 2018; Levendusky 2013; Matuszewski and Szabó 2019; Quattrociocchi, Scala, and Sunstein 2016). The lack of a notable connection between social media usage and political polarization in Germany suggests that other factors may play a more crucial role in shaping voters' political views.

The answer provided by this study is convincing to a certain extent, given the robust methodological approach and the alignment with existing literature. However, there are limitations that need further consideration. One such limitation is the operationalization of political social media usage, which was measured by the number of days per week respondents engaged with political content on social media. This measure may not fully capture the intensity or quality of social media interactions, potentially overlooking more nuanced effects. Additionally, the study's reliance on self-reported data could introduce biases, as respondents might underreport or overreport their social media usage. These factors suggest that the findings should be interpreted with caution.

Future research should aim to address the limitations identified in this study. One potential approach is the inclusion of a dataset with more waves of data to better capture longitudinal trends in political polarization. Additionally, employing a more representative sampling method could enhance the generalizability of the findings. Researchers could also explore alternative measures of social media usage that account for the intensity and quality of interactions, rather than just the frequency. Furthermore, incorporating time-invariant variables into the analysis through alternative modeling techniques, such as random effects models or mixed-effects models (if those models were to fit to the data), could provide a more comprehensive understanding of the factors influencing political polarization.

More research is required in various areas to enhance our comprehension of the connection between social media usage and political polarization. To begin with, further studies are required to investigate how different social media platforms and their distinct characteristics influence political beliefs. Various platforms can impact polarization differently depending on their unique user demographics and algorithms for content delivery. In addition, studying how social media usage affects various demographic groups may provide valuable insights on the interaction between age, gender, and socioeconomic status in political social media engagement. Future research can expand on the results of this study and enhance our understanding of the relationship between social media and political polarization by filling these gaps.

Literature

- Abramowitz, Alan I., and Kyle L. Saunders. 2008. "Is Polarization a Myth?" *The Journal of Politics* 70(2): 542–55. doi:10.1017/S0022381608080493.
- Allcott, Hunt, Luca Braghieri, Sarah Eichmeyer, and Matthew Gentzkow. 2020. "The Welfare Effects of Social Media." *American Economic Review* 110(3): 629–76. doi:10.1257/aer.20190658.
- Bail, Christopher A., Lisa P. Argyle, Taylor W. Brown, John P. Bumpus, Haohan Chen, M. B. Fallin Hunzaker, Jaemin Lee, et al. 2018. "Exposure to Opposing Views on Social Media Can Increase Political Polarization." *Proceedings of the National Academy of Sciences* 115(37): 9216–21. doi:10.1073/pnas.1804840115.
- Bakshy, Eytan, Solomon Messing, and Lada A. Adamic. 2015. "Exposure to Ideologically Diverse News and Opinion on Facebook." *Science* 348(6239): 1130–32. doi:10.1126/science.aaa1160.
- Banks, Antoine, Ernesto Calvo, David Karol, and Shibley Telhami. 2021. "#PolarizedFeeds: Three Experiments on Polarization, Framing, and Social Media." *The International Journal of Press/Politics* 26(3): 609–34. doi:10.1177/1940161220940964.
- Barberá, Pablo. 2014. "How Social Media Reduces Mass Political Polarization. Evidence from Germany, Spain, and the U.S." *Job Market Paper*.
- Beam, Michael A., Myiah J. Hutchens, and Jay D. Hmielowski. 2018. "Facebook News and (de)Polarization: Reinforcing Spirals in the 2016 US Election." *Information, Communication & Society* 21(7): 940–58. doi:10.1080/1369118X.2018.1444783.
- Berman, Ron, and Zsolt Katona. 2016. "The Impact of Curation Algorithms on Social Network Content Quality and Structure." *SSRN Electronic Journal*. doi:10.2139/ssrn.2848526.
- Boulianne, Shelley, Karolina Koc-Michalska, and Bruce Bimber. 2020. "Right-Wing Populism, Social Media and Echo Chambers in Western Democracies." *New Media & Society* 22(4): 683–99. doi:10.1177/1461444819893983.
- Boxell, Levi, Matthew Gentzkow, and Jesse M. Shapiro. 2017. "Greater Internet Use Is Not Associated with Faster Growth in Political Polarization among US Demographic Groups." *Proceedings of the National Academy of Sciences of the United States of America* 114(40): 10612–17. doi:10.1073/pnas.1706588114.
- Chan, Chung-hong, Cassius Siu-lun Chow, and King-wa Fu. 2019. "Echoslammings: How Incivility Interacts with Cyberbalkanization on the Social Media in Hong Kong." *Asian Journal of Communication* 29(4): 307–27. doi:10.1080/01292986.2019.1624792.
- Cho, Jaeho, Saifuddin Ahmed, Heejo Keum, Yun Jung Choi, and Jong Hyuk Lee. 2018. "Influencing Myself: Self-Reinforcement Through Online Political Expression." *Communication Research* 45(1): 83–111. doi:10.1177/0093650216644020.
- Conover, Michael, Jacob Ratkiewicz, Matthew Francisco, Bruno Goncalves, Filippo Menczer, and Alessandro Flammini. 2021. "Political Polarization on Twitter." *Proceedings of the*

- International AAAI Conference on Web and Social Media* 5(1): 89–96. doi:10.1609/icwsm.v5i1.14126.
- Dalton, Russell J. 1987. “Generational Change in Elite Political Beliefs: The Growth of Ideological Polarization.” *The Journal of Politics* 49(4): 976–97. doi:10.2307/2130780.
- Di Tella, Rafael. 2021. *Does Social Media Cause Polarization? Evidence from Access to Twitter Echo Chambers during the 2019 Argentine Presidential Debate*. Cambridge, Mass: National Bureau of Economic Research.
- DiMaggio, Paul, John Evans, and Bethany Bryson. 1996. “Have American’s Social Attitudes Become More Polarized?” *American Journal of Sociology* 102(3): 690–755. doi:10.1086/230995.
- Dubois, Elizabeth, and Grant Blank. 2018. “The Echo Chamber Is Overstated: The Moderating Effect of Political Interest and Diverse Media.” *Information, Communication & Society* 21(5): 729–45. doi:10.1080/1369118X.2018.1428656.
- European Parliament. 2024. “Comparative Tool | 2024 European Election Results.” *Comparative tool*. <https://results.elections.europa.eu/en/tools/comparative-tool/> (June 23, 2024).
- Festinger, Leon. 1957. *A Theory of Cognitive Dissonance*. Stanford: Stanford University Press.
- Frimer, Jeremy A., Linda J. Skitka, and Matt Motyl. 2017. “Liberals and Conservatives Are Similarly Motivated to Avoid Exposure to One Another’s Opinions.” *Journal of Experimental Social Psychology* 72: 1–12. doi:10.1016/j.jesp.2017.04.003.
- Gainous, Jason, Jason P. Abbott, and Kevin M. Wagner. 2021. “Active vs. Passive Social Media Engagement with Critical Information: Protest Behavior in Two Asian Countries.” *The International Journal of Press/Politics* 26(2): 464–83. doi:10.1177/1940161220963606.
- Garimella, Kiran, Gianmarco De Francisci Morales, Aristides Gionis, and Michael Mathioudakis. 2018. “Political Discourse on Social Media: Echo Chambers, Gatekeepers, and the Price of Bipartisanship.” In *Proceedings of the 2018 World Wide Web Conference on World Wide Web - WWW ’18*, Lyon, France: ACM Press, 913–22. doi:10.1145/3178876.3186139.
- Garrett, R. Kelly. 2013. “Selective Exposure: New Methods and New Directions.” *Communication Methods and Measures* 7(3–4): 247–56. doi:10.1080/19312458.2013.835796.
- Gidron, Noam, James Adams, and Will Horne. 2019. “Toward a Comparative Research Agenda on Affective Polarization in Mass Publics.” *APSA Comparative Politics Newsletter* 29: 30–36.
- GLÉS. 2023. “GLÉS Panel 2016-2021, Waves 1-21.” GESIS, Cologne, ZA6838 datafile Version 6.0.0, <https://doi.org/10.4232/1.14114>.
- Gruzd, Anatoliy, and Jeffrey Roy. 2014. “Investigating Political Polarization on Twitter: A Canadian Perspective: Investigating Political Polarization on Twitter.” *Policy & Internet* 6(1): 28–45. doi:10.1002/1944-2866.POI354.

- Handelsblatt. 2024. "Bundesregierung: Warum die Ampel nicht aus dem Umfragetief kommt." <https://www.handelsblatt.com/politik/deutschland/bundesregierung-warum-die-ampel-nicht-aus-dem-umfragetief-kommt/100017399.html> (June 23, 2024).
- Hare, Christopher, and Keith T. Poole. 2014. "The Polarization of Contemporary American Politics." *Polity* 46(3): 411–29. doi:10.1057/pol.2014.10.
- Hasell, A., and Brian E. Weeks. 2016. "Partisan Provocation: The Role of Partisan News Use and Emotional Responses in Political Information Sharing in Social Media: Partisan News, Emotions, and Information Sharing." *Human Communication Research* 42(4): 641–61. doi:10.1111/hcre.12092.
- Hong, Sounman, and Sun Hyoung Kim. 2016. "Political Polarization on Twitter: Implications for the Use of Social Media in Digital Governments." *Government Information Quarterly* 33(4): 777–82. doi:10.1016/j.giq.2016.04.007.
- Iyengar, Shanto, Yphtach Lelkes, Matthew Levendusky, Neil Malhotra, and Sean J. Westwood. 2019. "The Origins and Consequences of Affective Polarization in the United States." *Annual Review of Political Science* 22(1): 129–46. doi:10.1146/annurev-polisci-051117-073034.
- Iyengar, Shanto, and Sean J. Westwood. 2015. "Fear and Loathing across Party Lines: New Evidence on Group Polarization." *American Journal of Political Science* 59(3): 690–707. doi:10.1111/ajps.12152.
- Johnson, Thomas J., Barbara K. Kaye, and Angela M. Lee. 2017. "Blinded by the Spite? Path Model of Political Attitudes, Selectivity, and Social Media." *Atlantic Journal of Communication* 25(3): 181–96. doi:10.1080/15456870.2017.1324454.
- Jones, D. A. 2002. "The Polarizing Effect of New Media Messages." *International Journal of Public Opinion Research* 14(2): 158–74. doi:10.1093/ijpor/14.2.158.
- Kemp, Simon. 2024. "Digital 2024: Germany." *DataReportal*. <https://datareportal.com/reports/digital-2024-germany> (June 23, 2024).
- Kim, Yonghwan. 2015. "Does Disagreement Mitigate Polarization? How Selective Exposure and Disagreement Affect Political Polarization." *Journalism & Mass Communication Quarterly* 92(4): 915–37. doi:10.1177/1077699015596328.
- Kim, Yonghwan. 2019. "How Cross-Cutting News Exposure Relates to Candidate Issue Stance Knowledge, Political Polarization, and Participation: The Moderating Role of Political Sophistication." *International Journal of Public Opinion Research* 31(4): 626–48. doi:10.1093/ijpor/edy032.
- Kim, Yonghwan, and Youngju Kim. 2019. "Incivility on Facebook and Political Polarization: The Mediating Role of Seeking Further Comments and Negative Emotion." *Computers in Human Behavior* 99: 219–27. doi:10.1016/j.chb.2019.05.022.
- Knobloch-Westerwick, Silvia, Cornelia Mothes, Benjamin K. Johnson, Axel Westerwick, and Wolfgang Donsbach. 2015. "Political Online Information Searching in Germany and the United States: Confirmation Bias, Source Credibility, and Attitude Impacts: Political

- Online Information Search in Germany and United States.” *Journal of Communication* 65(3): 489–511. doi:10.1111/jcom.12154.
- Koch, Von Wolfgang. 2023. “Soziale Medien werden 30 Minuten am Tag genutzt – Instagram ist die Plattform Nummer eins.” *Ergebnisse der ARD/ZDF-Onlinestudie 2023*. https://www.ard-zdf-onlinestudie.de/files/2023/MP_26_2023_Onlinestudie_2023_Social_Media.pdf (June 23, 2024).
- Kubin, Emily, Curtis Puryear, Chelsea Schein, and Kurt Gray. 2021. “Personal Experiences Bridge Moral and Political Divides Better than Facts.” *Proceedings of the National Academy of Sciences* 118(6): e2008389118. doi:10.1073/pnas.2008389118.
- Kubin, Emily, and Christian Von Sikorski. 2021. “The Role of (Social) Media in Political Polarization: A Systematic Review.” *Annals of the International Communication Association* 45(3): 188–206. doi:10.1080/23808985.2021.1976070.
- Lee, Changjun, Jieun Shin, and Ahreum Hong. 2018. “Does Social Media Use Really Make People Politically Polarized? Direct and Indirect Effects of Social Media Use on Political Polarization in South Korea.” *Telematics and Informatics* 35(1): 245–54. doi:10.1016/j.tele.2017.11.005.
- Lee, Sangwon, Hernando Rojas, and Masahiro Yamamoto. 2022. “Social Media, Messaging Apps, and Affective Polarization in the United States and Japan.” *Mass Communication and Society* 25(5): 673–97. doi:10.1080/15205436.2021.1953534.
- Levendusky, Matthew S. 2013. “Why Do Partisan Media Polarize Viewers?” *American Journal of Political Science* 57(3): 611–23. doi:10.1111/ajps.12008.
- Marchal, Nahema. 2022. “‘Be Nice or Leave Me Alone’: An Intergroup Perspective on Affective Polarization in Online Political Discussions.” *Communication Research* 49(3): 376–98. doi:10.1177/00936502211042516.
- Marozzo, Fabrizio, and Alessandro Bessi. 2018. “Analyzing Polarization of Social Media Users and News Sites during Political Campaigns.” *Social Network Analysis and Mining* 8(1): 1. doi:10.1007/s13278-017-0479-5.
- Matthes, Jörg, Andreas Nanz, Ruta Kaskeleviciute, Franz Reiter, Isabelle Freiling, Ariadne Neureiter, Marlis Stubenvoll, et al. 2023. “The Role of Media in Political Polarization| The Way We Use Social Media Matters: A Panel Study on Passive Versus Active Political Social Media Use and Affective Polarization.” *International Journal of Communication* 17(0): 23.
- Matuszewski, Paweł, and Gabriella Szabó. 2019. “Are Echo Chambers Based on Partisanship? Twitter and Political Polarity in Poland and Hungary.” *Social Media + Society* 5(2): 205630511983767. doi:10.1177/2056305119837671.
- Nordbrandt, Maria. 2023. “Affective Polarization in the Digital Age: Testing the Direction of the Relationship between Social Media and Users’ Feelings for out-Group Parties.” *New Media & Society* 25(12): 3392–3411. doi:10.1177/14614448211044393.

- Ondercin, Heather Louise, and Mary Kate Lizotte. 2021. "You've Lost That Loving Feeling: How Gender Shapes Affective Polarization." *American Politics Research* 49(3): 282–92. doi:10.1177/1532673X20972103.
- Papacharissi, Zizi. 2019. "The Virtual Sphere. The Internet as a Public Sphere." In *Praktiken der Überwachen*, eds. Martin Stempfhuber and Elke Wagner. Wiesbaden: Springer Fachmedien Wiesbaden, 43–60. doi:10.1007/978-3-658-11719-1_3.
- Quattrociocchi, Walter, Antonio Scala, and Cass R. Sunstein. 2016. "Echo Chambers on Facebook." *SSRN Electronic Journal*. doi:10.2139/ssrn.2795110.
- Rathje, Steve, Jay J. Van Bavel, and Sander Van Der Linden. 2021. "Out-Group Animosity Drives Engagement on Social Media." *Proceedings of the National Academy of Sciences* 118(26): e2024292118. doi:10.1073/pnas.2024292118.
- Schmid, Fabiana, Oliver Treib, and Franziska Eckardt. 2023. "The Virus of Polarization: Online Debates about Covid-19 in Germany." *Political Research Exchange* 5(1): 2150087. doi:10.1080/2474736X.2022.2150087.
- Shanto Iyengar, Shanto Iyengar, Gaurav Sood, Gaurav Sood, Yphtach Lelkes, and Yphtach Lelkes. 2012. "Affect, Not Ideology A Social Identity Perspective on Polarization." *Public Opinion Quarterly* 76(3): 405–31. doi:10.1093/poq/nfs038.
- Stroud, Natalie Jomini. 2010. "Polarization and Partisan Selective Exposure." *Journal of Communication* 60(3): 556–76. doi:10.1111/j.1460-2466.2010.01497.x.
- Sunstein, Cass R. 2001. *Echo Chambers: Bush v. Gore, Impeachment, and Beyond*. Princeton University Press Princeton, NJ.
- Tucker, Joshua, Andrew Guess, Pablo Barbera, Cristian Vaccari, Alexandra Siegel, Sergey Sanovich, Denis Stukal, and Brendan Nyhan. 2018. "Social Media, Political Polarization, and Political Disinformation: A Review of the Scientific Literature." *SSRN Electronic Journal*. doi:10.2139/ssrn.3144139.
- Urman, Aleksandra. 2020. "Political Polarisation on Social Media in Different National Contexts." Inaugural Dissertation, Faculty of Business, Economics and Social Sciences, University of Bern, CH. <http://boristheses.unibe.ch/2211/> (March 19, 2024).
- Valenzuela, Sebastián, Ingrid Bachmann, and Matías Bargsted. 2021. "The Personal Is the Political? What Do WhatsApp Users Share and How It Matters for News Knowledge, Polarization and Participation in Chile." *Digital Journalism* 9(2): 155–75. doi:10.1080/21670811.2019.1693904.
- Verduyn, Philippe, Oscar Ybarra, Maxime Résibois, John Jonides, and Ethan Kross. 2017. "Do Social Network Sites Enhance or Undermine Subjective Well-Being? A Critical Review." *Social Issues and Policy Review* 11(1): 274–302. doi:10.1111/sipr.12033.
- Yarchi, Moran, Christian Baden, and Neta Kligler-Vilenchik. 2021. "Political Polarization on the Digital Sphere: A Cross-Platform, Over-Time Analysis of Interactional, Positional, and Affective Polarization on Social Media." *Political Communication* 38(1–2): 98–139. doi:10.1080/10584609.2020.1785067.

AI Directory


AI-based tool	Form of use	Affected parts of the work
DeepL Write	Correction and stylistic adjustments	Parts of the text
DeepL Translate	Translation of specific words and phrases	Parts of the text
ChatGPT (OpenAI)	Correction, labeling, and cleaning of R code	Parts of the code

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 Bern, 6/23/2024

Simon Bernhard

 Bern, 6/23/2024

Kevin Schlöpfer

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