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Social media and perceived climate change efficacy: A European comparison

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ABSTRACT

Climate change perceptions interact with how climate change is portrayed in the news, which is now increasingly accessed via social media platforms. While their effects on climate change awareness have been documented, it is less clear to what extent news consumed via social media platforms influences perceived climate change efficacy, which refers to the belief that one is able to make a difference in the fight against climate change. Our paper investigates the relationship between internet use, news received via social media, and perceived climate change efficacy in Europe, by using multilevel regression that shows the effects on individual, national and regional level. We find that there are modest differences between perceived climate change efficacy within our European sample and that on aggregated, national level Facebook negatively correlates with perceived climate change efficacy. Furthermore, regions with high participation in social media, show lower perceived climate change efficacy. Our multi-level research design thus puts new insights into the spatial manifestation of climate change opinions in the context of a digital geography interested in exploring differences in the effects of digital media uses.

1. Introduction

Scientific consensus on the anthropogenic cause of climate change seems overwhelming. Only small segments of the public (e.g. some (influential) members of the US Republican Party (McCright & Dunlap, 2010)) still perceive the causes and consequences of climate change – indeed, its very existence – as controversial (Westerstahl Stenport & Vachula, 2017). In Europe, climate change is overwhelmingly perceived as a worrying reality, with modest variations in awareness and risk perceptions between countries, where Eastern European populations show slightly less awareness and somewhat smaller risk perceptions (Poortinga et al., 2019). While awareness and risk perception in Europe are overall high, it is less clear whether people perceive themselves as capable to positively contribute against climate change through their own actions.

Hence, this paper investigates how *perceived climate change efficacy* is distributed within the European population. Psychologist Bandura highlights the importance of efficacy as follows:

> "Among the mechanisms of human agency, none is more focal or pervading than the belief of personal efficacy. This core belief is the foundation of human agency. Unless people believe that they can produce desired effects and forestall undesired ones by their actions, they have little incentive to act" (Bandura, 2000 p.75).

The efficacy concept has been used within research on public climate change perceptions (e.g. Milfont, 2012; Milfont et al., 2015) and in climate change communications (Crosman, Bostrom, & Hayes, 2019), however, larger cross country comparisons into perceived climate change efficacy are non-existent, to our knowledge. Climate change perceptions, including efficacy beliefs, are in large part shaped by socio-demographic predictors (Lee et al., 2015). However, media representations can equally affect climate change perceptions and perceived efficacy (Painter & Ashe, 2012). Especially, the rise of social media and its increasing share in people's news consumption make it an important phenomenon to study in the context of climate change perceptions (Corner, 2017). While the effects of social media platforms like the micro-blogging service Twitter on individual climate change perceptions and actions have been documented (Fownes, Yu, & Drew, 2018; Pearce et al., 2018), it is less clear to what extent news consumed via other social media platforms affects perceptions of climate change. Especially, the influence of content communities (YouTube) or social networks like Facebook, Facebook Messenger and Instagram on perceived climate change efficacy remains to be investigated. We

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believe that the continuing trust of users in social media services like Facebook, despite the rise of so-called 'Fake News', gives this topic a particular urgency (Lutzke et al., 2019).

Hence, we start to address this knowledge gap in our research paper, by contributing rare comparative insights about the relation between perceived climate change efficacy and news consumed via social media across 17 European states, 81 regions and three platforms (Facebook (plus Facebook Messenger), Instagram and YouTube). Europe is an interesting region to study because of its leadership role in the international fight against climate change (Schreurs & Tiberghien, 2007). Our shift in focus from climate change awareness and risk perception to perceived climate change efficacy is further warranted in an EU context due to reported high climate change awareness, yet unknown public levels of efficacy beliefs.

Whilst drawing on literature from communication studies and psychology, we find particular value within emerging debates in the realm of digital geography that attends to *differences* (Kinsley, McLean, & Maalsen, 2020) in the spatial manifestations of social platform interactions (Arthur & Williams, 2019; Pick, Sarkar, & Rosales, 2019). We contribute to such a digital geography by showing the importance to better understand the geographic contexts in which digitally mediated climate change opinions emerge, which could for example support a better tailoring of political campaigns and policies to foster climate change efficacy. Such insights are especially needed as the EUs multi-level governance is singled out as both advantage and disadvantage for developing climate change policies in Europe and both regional and national commitments need to be high (Parker, Karlsson, & Hjerpe, 2017). Hence, knowing more about individual, national and regional variations of perceived climate change efficacy is politically important within an EU context.

Precisely, what we do in this paper then is to conduct a multi-level regression analysis. We draw on the European Social Survey for data on the individual level, including perceived climate change efficacy. We combine this survey with data on social media consumption from Eurostat and the Reuters Institute Digital News Report (Newman et al., 2019) which is available on aggregated, national level only. First, we test individual level factors that determine perceived climate change efficacy, as cross-country studies are still surprisingly rare on this aspect of climate change beliefs. In a second step, we then investigate how the national use of social media platforms (Facebook, Instagram and YouTube as well as Facebook Messenger) for receiving news influences climate change efficacy across 17 EU countries. Third, we look at (sub-national) regional differences to reveal intra-national diversity. Our study finds that on a national level only the use of Facebook for receiving news correlates with perceived climate change efficacy across our European sample. On a regional level, we find that climate change efficacy beliefs are lower in regions with high use of social media. We propose enhancing social media literacy and strategies for fostering critical assessment of online news items within our conclusion.

2. Climate change efficacy and social media platforms

2.1. The individual level: Socio-demographics and personal internet use

Work on internal efficacy or self-efficacy, in the context of climate change draws on theories from behavioural sciences (Bostrom, Hayes, & Crosman, 2019; Crosman et al., 2019; Hart & Feldman, 2016; Kellstedt, Zahran, & Vedlitz, 2008; Milfont, 2012; Milfont et al., 2015).

In particular, Milfont et al. (2015) have contributed insights into various socio-demographic factors that influence both climate change awareness and perceived climate change efficacy, which are highly correlating aspects of a person's climate change perception:

> "Uniformly high beliefs in climate change reality and human cause was observed among respondents who were younger, female, educated, politically liberal, belonged to minority groups and who perceived that they were able to influence environmental outcomes" (Milfont et al., 2015: 17).

Research confirms that values, political attitudes and trust in political institutions positively influence climate change opinions (Drews & van den Bergh, 2015; Hornsey et al., 2016). Efficacy is a particularly important aspect of political discourses on civic participation, as it entails both a sense of knowing about ones' own place and capacity within a political system, but also carries a motivational dimension for people to participate in such a system (Vraga et al., 2015). Thus, we know from the literature that socio-demographic factors and personal opinions (age, gender, education, climate change awareness, values, and political orientation) are key predictors for personal climate change efficacy. Studies from the US further strengthen the role of socio-demographic predictors as McCright and Dunlap (2011) highlight how persistent climate scepticism is among conservative while males: " […] the conservative white male effect remains significant when controlling for the direct effects of political ideology, race, and gender as well as the effects of nine control variables" (McCright & Dunlap, 2011, p. 1163).

Apart from socio-demographic factors, researchers have attended to how individuals' perceived climate change efficacy is fostered or hampered by the ways in which climate change is framed within the media (Schäfer, 2012). While media representations and media consumption affect public opinions, there is no one-way street between media posts and opinion formation. Rather, media scholars have proposed a "circuit of culture [model which] has semiotic processes of 'encoding' and 'decoding' meanings in verbal and visual texts, constrained by contextual factors, at its heart" (Carvalho & Burgess, 2005, 1458). Crucially: "Audiences, through their own meaning-making practices, decode media communications in the contexts of their everyday lives: 'readings' that may or may not accord with the framings offered by the media" (ibid.).

With the rise of social media platforms and online newspapers (Ruiu, 2017) the media worlds we inhabit become increasingly diverse and heterogeneous opinions –that we can reject, embrace or ignore- are expressed around us (Bruns, 2019). Platforms like Facebook or Youtube, for example, contribute to the elimination of traditional hierarchies between those who create news and those who receive news through user based content, increasing the diversity of expressed opinions (Gil de Zúñiga, Jung, & Venezuela, 2012; Porten-Cheé & Eilders, 2015). Given this rise of media diversity, selected studies come to quite different assessments of how the media shapes perceptions of climate change. Vraga et al. (2015) find that higher frequencies of using online sources for topic-specific information on climate change enhances the efficacy beliefs of their US sample of Republican voters. A study from Taiwan found that the use of print media and television enhanced the participant's climate change awareness and perceived efficacy and willingness to adopt environmentally-friendly behaviour (Huang, 2016). The same study also foregrounds that the use of the internet equally has a beneficial effect on people's perceived climate change efficacy. In the context of climate change, online activists frequently use the internet and affordances of social media platforms for various different activities such as awareness raising, debunking of fake news, organising events and protests, verifying statements, intervening into debates by harnessing the affordance of audio-visual social media posts etc. (Hautea, Parks, Takahashi, & Zeng, 2021; Boulianne, Lalancette, & Ilkiw, 2020; Askanius & Uldam, 2011;).

However, a US study raises concern with such positive findings, as here the internet was not found to have any positive effect on political interest, efficacy, and knowledge (Richey & Zhu, 2015). While not exclusively concerned with climate change, the study found that general internet use was not beneficial for efficacy beliefs. Similar to our study, the paper analysis general amounts of internet use, rather than more specific individual practices, making it particularly relevant for our hypothesis building as we are working with similarly general data.

Hence, we first assume that socio-demographic factors are salient for

understanding what shapes perceived climate change efficacy. Second, given that general internet use does not enhance efficacy believes in the US study (Richey & Zhu, 2015), we assume that time spend online has little positive effects on people's personal climate change efficacy in the EU neither. Thus, our first research question (RQ) is:

RQ 1. *How do socio-demographic factors and time spent online shape perceived climate change efficacy in Europe?*

2.2. The national level: receiving news through social media and aggregated effects

Personal commitment against climate change, however, needs to be embedded in wider political action (e.g. policies, laws etc.) (Crosman et al., 2019). Consequently, perceived efficacy is not only shaped by individual factors but also by socio-cultural, political and economic factors on a regional and national scale (Ockwell, Whitmarsh, & O'Neill, 2009; Thaker et al., 2014).

In particular, national differences between perceived climate change efficacy and news consumption have been explored (Painter, Kristiansen, & Schäfer, 2018; Winter, Brückner, & Krämer, 2015). The growing trend of receiving news via social media platforms motivates our scrutiny towards this phenomenon in our data. Especially the rise of so-called Fake News (Adam & Häussler, 2019; Bessi et al., 2016; da Costa & Cukierman, 2019; Lutzke et al., 2019) motivates our critical scrutiny towards the online life of climate change news on a national level. What is at stake here is to see whether or not news received via social media platforms impact climate change efficacy on an aggregated national (rather than individual) scale to better understand the magnitude of the increasing trend of turning to online news sources.

Research by Adam and Häussler (2019) has shown that the hyperlink setting activities of climate sceptics and climate supportive bloggers in Germany and the UK differs markedly. They conclude that climate sceptics set more hyperlinks and thereby exploit the affordances of the internet better for their cause, achieving higher visibility (Adam & Häussler, 2019). They also point out that most posts originate in the USA and reveal the transnational network of hyperlink setting. Their research points towards the importance of considering national settings in which individuals' online activities emerge. While their insights are worrying on their own right, first studies seem to support that there is indeed a national effect –and national differences- of the damage so called online "fake news" and disinformation can cause.

Comparing 18 Western democracies towards their resilience against online disinformation, Humprecht, Esser, and Van Aelst (2020) and Fletcher, Alessio, and Kleis Nielsen (2020), find that the spread of Fake News within both online and offline news is less evident within countries like Finland, Germany and the Netherlands that have large and widely used public media services. In contrast, the UK or Southern European countries (France, Spain, Italy) in which media outlets tend to be more polarised (e.g. countries here tend to have at least one large conservative and left-leaning news provider, rather than one strong centrist outlet) show higher degrees of fake news spreading. Given the above findings, we expect a negative correlation between climate change efficacy and news received via social media platforms on a national level. We thus ask:

RQ 2. *To what extend does the use of social media platforms (YouTube, Instagram, Facebook, Facebook Messenger) for receiving news influence perceived climate change efficacy nationally?*

2.3. The regional level: collective efficacy and online participation

Ockwell et al. (2009) view media discourses, newspapers, as well as discussions with friends, family and colleagues as important means of fostering pro-environmental attitudes, efficacy believes and behaviours. Such a perspective is sustained by more than 15 years of critical research that has pointed out the salient role the media plays for shaping civic debate on the topic (Ruiu, 2017). In the 21st century, such debates and discourses occur offline as often as online. Socio-political debates are held within parliaments, newspapers, the pub as much as on Facebook. Participation in socio-political debates online has thus been applauded for its democratising potential (Gil de Zúñiga et al., 2012). Whilst the internet affords a seemingly transnational space for online deliberations and interactions, geography still matters. Numerous studies have found that most interactions between users occur within spatially proximate regions (Lengyel, Varga, Ságvári, Jakobi, & Kertsz, 2015; Sobolevsky et al., 2013). In fact, Arthur and Williams (2019) found how different UK regions have different online communication cultures and Pick et al. (2019) point out that in the US different regions prefer different online platforms for communication. Thus, a spatially attuned approach to investigating online participation in debates seems warranted and contributes to growing research interests in digital geography.

Critical scrutiny seems needed as Facebook and other social media platforms are said to be prone to produce so-called "echo chambers" or "filter bubbles" in which opinions on socio-political issues such as national elections, the Brexit debate or climate change are particularly polarized and increasingly decoupled from mainstream perspectives on these issues (; Grömping, 2014). Critical academics from the field of media studies, however, have debunked over-simplistic and tech-driven ideas of both "filter bubbles" and "echo chambers", pointing out that there is no clear definition of either term and thus robust empirical research into the precise workings of the two alleged phenomena is limited (Bruns, 2019; Dubois & Blank, 2018). Moreover, Bruns (2019) highlights that what research needs to do is to better understand the complex social factors and diverse ways in which people interact with heterogeneous (online/off-line) media worlds to understand the socio-political mechanisms that push (very few) people to fully decouple from mainstream discourses. A recent contribution (Williams, McMurray, Kurz, & Lambert, 2015) on the topic showed that Twitter indeed affords both the chance to only interact with like-minded people or engage in discussions within "mixed-attitude" communities. Furthermore, tendencies of engaging with like-minded people primarily, are not an exclusive strategy of climate sceptics, but can also be found among activist groups (ibid).

While filter bubbles and echo chambers are thus unhelpful metaphors here, theories from communication studies can support making sense of people's online participation in climate change debates. First, a recent study from Germany found that people, who are more sceptical about climate change, tend to participate more within online debates (Arlt et al., 2018: 93). This finding can be explained with the "corrective action hypothesis" by Rojas (2010). It means that people feel more provoked to react and contribute to debate when their assumptions are being challenged (Arlt et al., 2018: 94). Anonymity or the use of pseudonyms may further enhance people's willingness to express niche opinions online and intensify the extent to which people feel probed to react to challenging assumptions (Walter, Brüggemann, & Engesser, 2018).

While some people apparently feel provoked to speak out online to correct what they perceive as misinformation, authors have also used the "spiral of silence theory" (Porten-Cheé & Eilders, 2015) to explain online participation. The spiral of silence theory proposes that people first, closely monitor the opinions and sentiments expressed within their environment (e.g. through social media networks) on a specific topic and second, only dare to speak out about public matters within settings in which they believe to hold a mainstream position (ibid.: 144). Thus a spiralling process is triggered in which only sentiments are expressed openly that are thought to belong to mainstream discourses. However, the spiralling effect can also lead to a reversal of the opinion climate when mainstream and niche opinion are initially mistaken. While both theories are distinct, the effect they describe is similar, namely that climate scepticism is expressed more frequently online.

Yet, little research has been conducted on the regional effects of people participating in online debates. In other words, it is unclear

whether socio-political debates online are geographically linked to particular regions and whether these regions in turn display higher or lower degrees of perceived climate change efficacy. This research gap can be seen as a severe omission, as online participation represents a new way of personalised political self-expression and can create situations of opinion leadership in which people may trust the digitally mediated opinions of friends and family more than offline-sources such as news reports (Arlt et al., 2018; Walter et al., 2018). Thus, a relatively small number of people expressing their views online can have a huge effect in terms of opinion leadership, which can for example affect voting behaviour.

The corrective action hypothesis and spiral of silence theory identified in the context of climate change perceptions, lead us to expect that regions with higher online participation and use of social media display lower degrees of perceived climate change efficacy. We thus ask:

RQ 3a. *To what extend does the online participation in socio-political debates affect perceived climate change efficacy on a regional level?*

RQ 3b. *To what extend does the use of social media affect perceived climate change efficacy on a regional level?*

3. Method

3.1. Data

The study uses the Round 8 sample of the European Social Survey (ESS) for data on the individual level that can be accessed at https://www.europeansocialsurvey.org/. The ESS contains random probability samples of the respective national populations, compiled in 2016, ranging from 880 for Iceland to 2852 for Germany, in a representative cross-national survey design (Poortinga et al., 2019). Included post -stratification weight was used to correct for the different probabilities of selection (Poortinga et al., 2019). The ESS sample covers a total of 44,387 individuals nested in 23 countries.

The ESS data was complemented with country-level data on using Facebook, Instagram, YouTube, and Facebook Messenger for news, trust in news from social media, as well as GDP per capita, and people with higher-education entrance qualifications (15 years and older) as controls. Data on using social media and using social media for socio-political discussions on the NUTS 1 regional level were also added. As regional level we use Eurostat's statistical regions of NUTS 1 as the biggest regional entity below the national level. The three-stage classification of NUTS (Nomenclature des unités territoriales statistiques, from NUTS 1 to 3) aims to make a territorial breakdown for regional statistics available all over the EU. For example, in Germany the NUTS 1 correspond with the 16 federal states, in small countries like Luxemburg, however, the NUTS 1 level is identical with the country level.

The regional level variables as well as the education variable were obtained from Eurostat (https://ec.europa.eu/eurostat/web/main/home), GDP from World Bank data (https://datacatalog.worldbank.org/), and the country-level social media data from the Newman et al., 2019 (http://www.digitalnewsreport.org/). This research was conducted by an online survey in January/February 2019. The samples in each country are weighted and representative for the respective population, using quotas for age, gender, region, and education. Interviewees who said that they had not consumed any news in the past month were filtered out (around 3% of the sample). For the Russian Federation, Israel, Lithuania, Estonia, Slovenia, and Iceland, the relevant social media data was not available. Thus, these countries were excluded from the final data set, which contains 30,227 respondents nested within 81 regions in 17 countries. The compilation of our data from different sources has at least two challenges that need to be discussed here. First, the data was collected at different times during a span of three years. Yet, we assume that this time span is able to depict the spatial context of social media use. For multi-level modelling a rigorous theoretical deduction of the different levels, as we revealed it in our theoretical part, is crucial for contextual variables as used in our analysis (Hox, Moerbeek, & van de Schoot, 2018). Second, the data was collected by different institutions and has different country/regional samples. However, all data used in the analysis was gathered from institutions with commensurable high data collection standards. We have limited our analysis to countries from which we were able to obtain all relevant information on individual, regional and national level. Given the robustness of the data collecting agencies, the large sample sizes, and the short time span between the collection of the different contextual variables, the resulting data set is able to give an adequate picture of how news received via social media influence perceived climate change efficacy in Europe. However, the data in their combination can only show clear tendencies of the connection between media use on the context level and climate change efficacy. The exact mechanisms of action of these contextual factors cannot be deduced via correlations. At this point, qualitative, subject-centred methods are needed to explain the effect of the contextual condition on the individual.

3.2. Variables

3.2.1. Dependent variable

The dependent variable of perceived climate change efficacy summarises five questions on attitudes towards climate change efficacy ($\alpha = 0.69$). Four questions could be answered on an eleven item scale, ranging from zero ("Not at all likely") to ten ("Extremely likely"). These were "Now imagine that large numbers of people limited their energy use. How likely do you think it is that this would reduce climate change?", "How likely do you think it is that large numbers of people will actually limit their energy use to try to reduce climate change?", "And how likely do you think it is that governments in enough countries will take action that reduces climate change?", and "How likely do you think it is that limiting your own energy use would help reduce climate change?". The fifth question, "To what extent do you feel a personal responsibility to try to reduce climate change?" also used an eleven item scale, ranging from "Not at all" to "A great deal". The final variable was calculated as the mean of the five items. Higher values represent greater perceived climate change efficacy.

3.2.2. Independent variables

3.2.2.1. Individual level. The impact of internet use is covered by two items at the individual level. 'Daily internet use' (dummy) controls for regularity, 'Internet use, time per day in minutes' allows for a differentiation in the frequency of use. Missing values are replaced by stochastic regression imputation (27.45%). However, this could cause a (too) permissive interference statistic in the regression models (Baltes-Götz, 2013). Thus, the coefficients of the imputed item should be interpreted with caution.

At the individual we use ten control variables (sex (dummy), age (centred on its grand mean of 47.03), education (International Standard Classification of Education – ISCED), metropolitan living, hedonistic values, altruistic values, traditional values, anti-immigrant attitude, trust in national politics, climate change awareness) derived from current studies on climate change attitudes (Capstick et al., 2015; Milfont et al., 2015).

For controlling political orientation (McCright et al., 2015), we use an anti-immigrant attitude scale ($\alpha = 0.84$), calculated as the mean of six items on opinions towards immigration and standardised as z-score (over 17 countries), as proxy for right-wing political orientation, because empirical work shows a high correlation between these items (Kleinert & Schlueter, 2020). While there is a strong link between environmentalism and left/liberal political parties in Western Europe, in Central and Eastern Europe left-wing parties, that is former socialist parties, tend to be more obstructive about environmental concerns (Rohrschneider & Miles, 2015). Hence, the anti-immigrant proxy is

used. We also include three scales of human values (z-scores of means over all 17 countries) representing hedonism ($\alpha = 0.78$), altruism ($\alpha = 0.72$), and traditionalism ($\alpha = 0.71$) (Schwartz, 1994), derived from 21 items from the included modified Portrait Values Questionnaire (PVQ) (Poortinga et al., 2019). Moreover, we include trust in politicians and political institutions (Drews & van den Bergh, 2015) on a scale ($\alpha = 0.91$) constructed as the mean (z-score over the 17 countries) of three items related to personal trust in these entities. Comparative climate change awareness research (Hornsey et al., 2016; Lee et al., 2015) suggests that climate change awareness is a strong foundation for perceived climate change efficacy (Milfont, 2012). To control for that effect, we include the item "Do you think the world's climate is changing?" and recode it into a dummy (awareness is indicated by 1) in a similar manner to Lee et al. (2015). The mean values of the dependent variable differ significantly between the two categories [$t = 12.3$; $p < 0.001$].

3.2.2.2. Aggregated level. For testing the influence of social media use on perceived climate change efficacy, we include use of Facebook, Instagram, YouTube, and Facebook Messenger for obtaining news in the last week in per cent respectively. Use is defined as using the medium at least once a week to get news. We also add trust in news from social media in per cent. Country level data is derived from Reuters Institute Digital News Report (2019). The use of online services in the population is compiled by a nationally representative online survey with sample sizes ranging from 2003 respondents in Switzerland to 2026 in the Netherlands. At the regional NUTS 1 level, which is also included in the ESS dataset, we include two items derived from Eurostat. People using social media in per cent and people using social media for socio-political discussions in per cent is included to test for the involvement with social media that is of particular interest. Use is defined as at least one use of the medium in the last three months. All country and regional level items are centred on their grand means. At the country level, attitudinal work on climate change has discussed the role of GDP and education as being influential for climate change perceptions (Hornsey et al., 2016; Lee et al., 2015). We therefore use these as controls. (See Table 1.)

3.3. Data analysis strategy

We use multilevel regression as the data is structured by individuals nested in regions and countries, and we expect that the effects of the individual predictors vary between the regional and country-level units. Five multilevel linear models were computed. Macro-level items are centred on their grand means to safeguard that the intercept can be understood as an anticipated value of the resulting variable. That means zero has to be meaningful (Hox, 2002). There is a controversial discussion in the literature about the question of the optimal number of random slopes in the models (Bryan & Jenkins, 2016; Heisig, Schaeffer, & Giesecke, 2017; Schmidt-Catran & Fairbrother, 2016). In order not to increase the complexity unnecessarily, we include random slopes for the control variables of anti-immigrant attitudes and trust in national policies, as it is obvious that the slopes differ between national contexts. The same applies to the two explanatory variables of daily internet use and daily time spent on the internet, which are also included as random slopes. We are interested in the general association between different levels and perceived climate change efficacy. Therefore, only fixed effects of the respective models are reported. We use Restricted Maximum Likelihood (RML) as the estimation method, which produces good estimates even for small numbers of groups (Hox, 2002; Stegmueller, 2013). As Hox et al. (2018) recommend for more complex models, we avoid inter-group interactions and include only items for which there is "strong theoretical or empirical justification" (Hox et al., 2018: 20). Generally, smaller sample size means that effects have to be greater if they are to be significant (Button et al., 2013), which has to be borne in mind when interpreting the macro-effects detected.

Table 1
Overview of measures used in the analysis.

	Definition	Data source
Dependent variable *(individual level)*	Mean of five items, each ranging from low (zero) to high (ten) efficacy. "Now imagine that large numbers of people limited their energy use: a) How likely do you think it is that this would reduce climate change? b) How likely do you think it is that large numbers of people will actually limit their energy use to try to reduce climate change? c) And how likely do you think it is that governments in enough countries will take action that reduces climate change? d) How likely do you think it is that limiting your own energy use would help reduce climate change? e) To what extent do you feel a personal responsibility to try to reduce climate change?"	European Social Survey (ESS)
Independent variables *(individual level)*	Sex (1 = male) Age (grand mean) Education by International Standard Classification of Education (ISCED) (grand mean) Metropolitan living (1 = yes) Anti-immigrant attitude (6 item scale, z-score) Hedonism by Portrait Values Questionnaire [PVQ] (9 item scale, z-score) Altruism by Portrait Values Questionnaire [PVQ] (6 item scale, z-score) Traditionalism by Portrait Values Questionnaire [PVQ] (6 item scale, z-score) Trust in national politics (3 item scale, z-score) CC Awareness (1 = yes) Daily internet use (1 = daily internet use) Internet use, time per day in minutes (imputed)	European Social Survey (ESS)
Independent variables *(country level)*	Use of Facebook for news 2019 (in %) Use of Instagram for news 2019 (in %) Use of YouTube for news 2019 (in %)	Newman et al., 2019
	Use of Facebook messenger for news 2019 (in %)	Eurostat
	Trust in news from social media 2019 (in %)	World Bank data
	People with higher education entrance qualifications (in %) 2018 GDP per Capita 2017	
Independent variables *(regional level)*	People using social media 2016 (in %) People using social media for socio-political discussions 2017 (in %)	Eurostat

Source: ESS 2016; Eurostat 2019; Newman et al., 2019; World Bank 2019.

4. Results

Our outcome shows that perceived climate change efficacy in Europe is relatively moderate, with significant albeit small regional differences. In particular, the three Eastern European countries in the sample show low levels of perceived climate change efficacy compared with the rest of the sample. The correlation coefficient between efficacy and internet use, time per day, at the individual level for each country gives an indication of the composition of this relationship in the sample (Table 2) (Pehrson, Vignoles, & Brown, 2009).

It is noticeable that this correlation is mostly negative across all countries, but only significant in five countries. However, it becomes apparent that long hours in the internet are rather associated with low

Table 2
Country-specific CC efficacy, daily internet use, and correlations (Pearson) between perceived climate change efficacy and internet use, time per day.

Country	Sample size	CC efficacy	Trust in national politics	Internet use, time per day in minutes	Daily internet use	Perceived CC efficacy/internet use correlation
	N	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*%*	*(Pearson)*
Austria	1814	5.076 *(1.72)*	4.309 (2.17)	160.3 *(132.7)*	58.4	0.033
Portugal	1131	5.137 *(1.72)*	3.083 (2.09)	219.2 *(199.4)*	53.3	0.031
Belgium	1732	5.146 *(1.39)*	4.263 (2.03)	188.9 *(167.8)*	63.9	0.022
Czech Republic	1978	4.077 *(1.63)*	3.892 (2.10)	198.8 *(169.5)*	54.2	0.011
Ireland	2554	5.200 *(1.49)*	4.058 (2.04)	191.4 *(152.6)*	66.2	0.002
Sweden	1482	5.415 *(1.48)*	5.188 (1.92)	231.5 *(85.0)*	81.1	−0.007
Spain	1614	5.086 *(1.61)*	2.920 (2.10)	212.2 *(183.6)*	65.3	−0.016
Norway	1500	5.109 *(1.46)*	5.852 (1.74)	213.3 *(166.2)*	85.3	−0.022
Poland	1377	4.893 *1.57)*	2.780 (2.07)	189.5 *(159.2)*	52.0	−0.023
Switzerland	1428	5.226 *(1.44)*	5.664 (1.68)	172.3 *(168.8)*	71.4	−0.024
Italy	2228	5.105 *(1.58)*	2.633 (2.18)	177.4 *(152.5)*	49.5	−0.028
Hungary	1374	4.595 *(1.68)*	3.929 (2.37)	202.2 *(169.3)*	47.0	−0.041
Germany	2723	4.879 *(1.41)*	4.496 (2.04)	187.3 *(170.4)*	62.5	−0.047*
Finland	1862	5.213 *(1.50)*	5.066 (2.06)	176.0 *(141.0)*	76.4	−0.050*
United Kingdom	1848	4.863 *(1.46)*	4.132 (2.01)	221.1 *(190.0)*	69.8	−0.058**
Netherlands	1603	5.032 *(1.38)*	5.300 (1.76)	230.8 *(213.3)*	82.6	−0.066**
France	1980	5.166 *(1.41)*	3.298 (1.90)	181.9 *(160.5)*	64.8	−0.070**
Sum/average	30,227	5.006 *(1.55)*	4.150 (2.02)	195.5 *(170.0)*	64.8	−0.068***

Source: ESS 2016; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

levels of perceived efficacy. At the aggregated level, this correlation is negative and significant.

The multilevel models show that individual factors make a large contribution to explaining climate change efficacy, which is comparable to results in climate change awareness research (Lee et al., 2015) (See Table 3.). The baseline model reveals that 96.4% of variance in the perceived climate change efficacy scale can be traced back to the individual level, 2.3% of variance to differences between the countries, and 1.3% to differences between the regions. Model 4 is able to explain 15.4% of variance (R^2).

4.1. Individual level

At the individual level model 2 makes clear that daily internet use and internet use in minutes per day are negatively correlated with perceived climate change efficacy. Strongest predictors are trust in national politics and an articulated awareness of climate change. As expected, anti-immigrant attitudes correlate negatively with efficacy implying that right wing attitudes are closely linked to climate scepticism in Europe (Poortinga et al., 2011). The three value dimensions of hedonism, altruism, and traditionalism all correlate positively with perceived climate change efficacy, whereas sex and metropolitan living are negatively associated.

4.2. National level

At the national level (model 3), we found that education at the country level has a negative effect on perceived climate change efficacy. The two Eastern European countries Hungary and Czech Republic, where education levels are high yet efficacy beliefs are low, have a significant influence here as 'people with higher-education entrance qualification' loses its significance if these two countries are excluded. The GDP of the country does not show a significant correlation with perceived climate change efficacy, which differs somewhat from Sandvik (2008), who observed that high levels of GDP negatively affect climate change awareness and public concern about climate change. In the broadest sense, GDP is also not independent of climate change and for this reason is at least controversial as a control variable (Burke, Hsiang, & Miguel, 2015). While trust in national politics is our second strongest variable at the individual level, trust in social media platforms at the country level plays an unexpectedly minor role for efficacy beliefs in Europe. This finding diverges from Lutzke et al. (2019), who provide evidence that respondents' trust in Facebook itself shapes the way they evaluated news received on the platform. Most importantly, the national level reveals that there is no significant correlation between use of social media platforms for news consumption and perceived climate change efficacy.

4.3. Regional level

At the regional level (NUTS 1) model 4 finds that in regions where many people participate in social media platforms, perceived climate change efficacy tends to be lower (Model 4), even though the mere correlation between climate change efficacy and using social media for socio-political discussions at the NUTS 1 level is weak but positive ($r = 0.012$; $p < 0.05$; [CI 0.001–0.024]). In contrast, participation in socio-political issues in social media correlates significantly positively with perceived climate change efficacy at the regional level ($r = 0.397$; $p <$

Table 3
Three-level regression models predicting the efficacy dimension of climate change in seventeen countries in Europe.

	Model (0) *β/SE* *Baseline*	Model (1) *β/SE* *Control*	Model (2) *β/SE* *Individual*	Model (3) *β/SE* *Country*	Model (4) *β/SE* *All*
Individual level		−0.143***		−0.140***	−0.140***
Sex *(1 = male)*		(0.018)	−0.139***	(0.018)	(0.018)
			(0.018)		
Age *(grand mean)*		0.002***	0.000	0.000	0.000
		(0.001)	(0.000)	(0.000)	(0.001)
Education *(grand mean)*		−0.013**	−0.007	−0.006	−0.006
		(0.005)	(0.005)	(0.005)	(0.005)
Metropolitan living *(1 = yes)*		−0.086**	−0.080**	−0.080**	−0.070**
		(0.027)	(0.028)	(0.028)	(0.028)
Hedonism *(z-score)*		0.115***	0.121***	0.122***	0.122***
		(0.010)	(0.010)	(0.010)	(0.010)
Altruism *(z-score)*		0.109***	0.111***	0.110***	0.111***
		(0.011)	(0.011)	(0.011)	(0.011)
Traditionalism *(z-score)*		0.058***	0.057***	0.055*	0.054***
		(0.011)	(0.011)	(0.011)	(0.011)
Anti-immigrant attitude *(z-score)*		−0.216***	−0.220***	−0.217***	−0.216***
		(0.036)	(0.031)	(0.026)	(0.024)
Trust in national politics *(z-score)*		0.333***	0.331***	0.333***	0.333***
		(0.036)	(0.031)	(0.026)	(0.024)
CC Awareness *(1 = yes)*		0.427***	0.417***	0.417***	0.419***
		(0.045)	(0.045)	(0.045)	(0.045)
Daily internet use *(1 = yes)*			−0.088*	−0.087**	−0.083**
			(0.037)	(0.033)	(0.031)
Internet use, time per day in minutes *(z-score)*			−0.061*	−0.063*	−0.063**
			(0.030)	(0.025)	(0.023)
Country level (Grand mean)				0.000	0.000
GDP per capita 2017		−0.000		(0.000)	(0.000)
		(0.000)			
People with higher-education entrance qualification per cent 2018		−0.012***		−0.011**	−0.012**
		(0.004)		(0.004)	(0.004)
Using Facebook for news, per cent				0.109	0.154+
				(0.072)	(0.078)
Using Instagram for news, per cent				0.010	−0.016
				(0.049)	(0.052)
Using YouTube for news, per cent				0.086	−0.064
				(0.070)	(0.082)
Using Facebook Messenger for news, per cent				−0.048	−0.030
				(0.055)	(0.052)
Trust in news from social media, per cent				−0.041	0.004
				(0.054)	(0.008)
NUTS 1 Region level (grand mean)					
People using social media, per cent 2018					−0.120**
					(0.041)
People using social media for socio-political discussions, per cent					−0.011
					(0.031)
Constant	5.002***	4.700***	4.773***	4.766***	4.709***
	(0.064)	(0.057)	(0.055)	(0.054)	(0.159)
Level 3: Regions (NUTS 1)	0.031	0.014	0.011	0.011	0.012
	(0.009)	(0.003)	(0.002)	(0.002)	(0.002)
Level 2: Countries	0.055	0.014	0.010	0.005	0.003
	(0.029)	(0.004)	(0.003)	(0.002)	(0.002)
Level 1: Individuals	2.310	2.023	2.012	2.012	2.012
	(0.019)	(0.017)	(0.017)	(0.017)	(0.017)
−2 Log Likelihood	112,139.206	96,125.855	95,984.873	96,013.690	95,978.719
n *Regions (NUTS 1)*	81	81	81	81	81
n *Countries*	17	17	17	17	17
n *Individual*	26,773	23,743	23,726	23,726	23,713

Source: EES 2016; Reuters Institute for the Study of Journalism 2019; Eurostat 2019; World Bank 2019; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

0.001; [CI 0.387–0.406]). Hence, regional variation in Europe highlights the need for further analysis of the rationales behind the correlation between climate change efficacy and participation in online socio-political discussions. While Adam and Häussler (2019) point out that people who are sceptical about the anthropogenic cause of climate change are more active in disseminating their views online, our observed regional effects portend in the opposite direction, albeit slightly due to the lack of significance in the regression model.

5. Discussion

Here we unpack and discuss our results along the three different levels of our investigation.

5.1. Individual Level

As expected, we found that daily internet use as well as the amount of time spent online negatively correlate with perceived climate change efficacy. While this contrasts with the study from Taiwan (Huang, 2016), where internet use was found to enhance climate change efficacy,

it fits the finding from the USA study where internet use did not enhance efficacy (Richey & Zhu, 2015). The negative relationship we found in the data is particularly significant in countries such as Germany, Finland, the UK, the Netherlands or France. Further studies are needed to investigate which specific types of internet and potential social media use could foster or negatively affect perceived climate change efficacy here. Unfortunately, our data does not permit for further conclusions or insights here.

Most of the variance in perceived climate change efficacy across our sample, however, can be explained with socio-demographic factors as expected and allows for deeper discussions. Climate change awareness is our strongest predictor for climate change efficacy, which confirms Milfont et al.'s (2015) statement that these variables are closely connected. Trust in politicians and institutions is the second most important variable foregrounding the important role political institutions and politicians play in fostering efficacy beliefs within the population. Research from across the world confirms our finding and warns that the belief in effective climate change policies decreases once a general sense of trust in the political system is lost (Drews & van den Bergh, 2015). While our finding that women show higher degrees of perceived climate change efficacy is in line with Milfont et al. (2015), we cannot confirm a correlation between youth and higher degrees of perceived climate change efficacy in our sample. We found that beliefs and values play a highly significant role for perceived climate change efficacy. Interestingly, all three categories (altruism, hedonism, traditionalism) were significant for positively contributing to perceived climate change efficacy. Furthermore, political orientation is highly significant, which corresponds to findings from Poortinga et al. (2019) who investigated the role of political orientation on climate change perceptions in Europe.

5.2. National level

We found that the influence of news received through social media only have a modest aggregated effect. In fact, only news received through Facebook has a negative correlation with perceived climate change efficacy at the $p < 0.1$ level, whereby the confidence interval of the point estimator here just includes zero. Nevertheless, based on the recent significance debates (Amrhein, Greenland, & McShane, 2019), we detect an effect of Facebook that is positive, albeit fragile. The use of other social media platforms for accessing news has no effect on perceived climate change efficacy nationally. This may point to a particular "platform culture" (Pearce et al., 2018) that distinguishes Facebook in terms of news consumption from platforms like Instagram or YouTube. Research on platform cultures has for example shown that debates on Twitter and Facebook differ in style and civility (Oz, Zheng, & Chen, 2018; Yi-Fan Su et al., 2018). Furthermore, Facebook is increasingly being used by older users, with younger people turning to other social network sites such as TikTok for entertainment but also networking and activism (Hautea et al., 2021). Data on specific user compositions of each site could help hence further unpack our finding. Unfortunately, our study lacks such data on individual platform users to say more about this.

Nevertheless, our findings point out how fragile the negative relation between perceived climate change efficacy and news received through social media platforms is. In fact, as Arlt et al. (2018) and Walter et al. (2018) have highlighted that within platforms opinion leadership can become a rather uncontrollable phenomenon. Sustained political and academic attention to the ways news are circulating through social networks online seems necessary as our findings show that there is a weak correlation that is manifest on the national scale.

5.3. Regional level

On a regional level, we found the use of social media for participating in debates on socio-political topics online has no effect of efficacy beliefs collectively. However, we found that regions where many people use social media, perceived climate change efficacy tends to be lower. This is an interesting finding as it might give a first indication that theories of individual online participation practices (e.g. theory of silence, corrective action hypothesis (see section 2.2.) might trigger a more collective effect as well. Furthermore, it seems that such a collective effect might manifest itself spatially within specific regions. We must be very careful here not to jump to premature conclusions, as we only observe collective numbers and not individual behaviour at this level of our regression analysis, but it gives us reason to call for further large-scale research to determine the group-effects of online participation and their spatial manifestation. Our study seems to confirm that the negative correlation between climate change beliefs and online participation on the individual level found by various authors (Arlt et al., 2018; Walter et al., 2018) appears to translate into collective negative correlations as well. Further important factors that could help shed light into this relation (e.g. predictors like local income distribution, regional voting behaviour, etc.) could further sustain such future research into regional differences of perceived climate change efficacy and the participation in online debates and social media use.

6. Conclusion

Our research found that there are individual, national and regional differences within the perceived climate change efficacy in our European sample, confirming our spatially-oriented research design. Our findings thus contribute to a digital geography that is interested in investigating the complex ways in which digital and non-digital spaces and practices overlap and interact to shape contemporary sociality (Kinsley et al., 2020). By far the largest variance can be explained by socio-demographic factors and individual internet consumption. Moreover, and the amount of time spent online per day negatively affects an individual's perceived climate change efficacy. This trend is particularly significant in Germany, Finland, the UK, the Netherlands and France. On a national level, we can observe that receiving news via Facebook decreases the aggregated perceived climate change efficacy across our sample to a small degree. This is a worrying finding that shows the effect of news being circulated selectively for instance within groups of friends on social media sites have. On a regional level, we find a similar pattern. Regions with higher participation in social media platforms show a lower perceived climate change efficacy. Given the multi-level climate change governance in Europe, it is important to collect such regional and national insights to devise tailored policy approaches that take the needs of different spatial units seriously.

In line with our multi-level regression we further conclude that first a greater cultivation of online media literacy might be useful to enhance perceived climate change efficacy in Europe. Work on media literacy in the context of climate change (Cooper, 2011), for example, supports an approach that promotes the skill of individuals to (re)discover and practice their ability to critically question the authorship, intentions and credibility of media sources. Yet, such an effort needs to be further sustained by regional and national efforts, e.g. by systematically integrating social media literacy in local education agendas.

While our paper contributes novel comparative insights, several pending questions need to be acknowledged that could be utilised by future research. First, based on the available data we offer detailed results for the individual level, yet only broad brush insights on regional and national level. More detailed survey data about individual internet use and online practices would be necessary to gain further insights into the specific ways of news consumption via social media and their relation with perceived climate change efficacy. Our compiled data set that draws on samples from different years and organisations does not permit drawing further conclusion and must be acknowledged as a limitation of our paper. Integrating questions of social media use and news consumption with questions of climate change efficacy within data collection thus seems all the more urgent. Further research could take our initial findings about the negative correlation between climate change

efficacy and news received via Facebook to continue investigations into the national and regional effects of online group dynamics prevalent here.

Declaration of Competing Interest

None.

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