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The great divide: understanding the role of media and other drivers of the partisan divide in public concern over climate change in the USA, 2001–2014

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Abstract Recent scholarship has identified a large and growing divide on how Republicans and Democrats view the issue of climate change. A number of these studies have suggested that this polarization is a product of systematic efforts to spread doubt about the reality of climate change through the media in general and conservative media in particular. However, research to date has largely relied on speculation about such a relationship rather than empirical evidence. We improve on existing research by conducting an empirical analysis of the factors affecting national-level, quarterly shifts in public concern about climate change between January 2001 and December 2014. Our analysis focuses on the potential role played by four factors that should account for changes in levels of concern regarding climate change: (1) media coverage, (2) extreme weather, (3) issuance of major scientific reports, and (4) changes in economic activity and foreign conflict. Some results suggest that partisan media influences beliefs in ways expected by communication scholars who describe "echo chamber" effects and "boomerang" effects. Among other supporting evidence, we find that partisan media not only strengthen views of like-minded audiences but also when Republicans are presented with opposing frames about climate change from liberal media, they appear to reject the messages such that they are less concerned about the issue. Findings also demonstrate that the dissemination of science increases concern about climate change among Democrats but has no influence on Republicans. Finally, extreme weather does not increase concern among Democrats or Republicans. Implications for future research are discussed.

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Although there is a significant partisan divide on climate change in the USA, this polarization has not always existed. One of the earliest polls on the issue (1989) conducted by the Gallup Organization asked respondents how worried they are about global warming. The results showed that partisan differences on the issue were virtually non-existent, with 67% of Democrats and 66% of Republicans indicating that they worried a great deal or fair amount about global warming. Just over a decade later (2001), Gallup repeated that poll and showed that a sizable partisan gap of 27% percent had emerged, which has not only persisted but increased since that time. In fact, when Gallop asks the same question in 2010, the gap between Republicans and Democrats had grown to 42%. Finally, in the 2016 Gallup Survey, this gap had risen to a 44% difference between Democrats, with an 84% level of concern, and Republicans, with a 40% level of concern. Perhaps most puzzling is the fact that this growing partisan divide emerged as the scientific community reached a near consensus on anthropogenic climate change (97% of the related science according to Cook et al. 2013). While a number of studies have attempted to explain the inconsistency between the scientific consensus and public views, only a handful have carefully examined the role that partisan media may play. More importantly, no previous study has assessed if and how a partisan media effect may vary according to the party of the audience. This void in the existing literature represents a rather substantial oversight given that a number of scholars have pointed to a sophisticated and coordinated denial movement operating through conservative media to increase doubt about climate change among an ideologically receptive audience (Dunlap 2013; Dunlap and McCright 2011).

The goal of the present study is to move beyond the bulk of the existing scholarship in this area, which has largely focused on individual-level explanations to account for the divergent views on climate change, through an examination of partisan shifts in aggregate, national-level concern about climate change that have taken place between 2001 and 2014. Doing so will allow us to carefully consider factors that individual-level studies leave unexplored, such as the extent to which partisan media, along with several other socio-economic factors, may help explain why the divide between Republicans and Democrats exists and why it may have widened over time.

In the first part of the paper, we provide a brief overview of the relevant literature. Much of the work on climate change public opinion has pointed to several key factors including (1) the availability of climate science that is digestible to the general public, (2) economic conditions, (3) extreme weather, and (4) media coverage of climate. While informative, this research does not examine shifts in *partisan* public opinion, nor the potentially unique impact that partisan media may have. The goal here is to fill that void in the literature. Using indicators of aggregate, partisan (i.e., Republican versus Democrat) public opinion as the dependent variables, we run several time series regression models to examine the influence of partisan media, extreme weather events, availability of scientific information, and a series of structural control variables on partisan public concern over climate change. Before providing a more detailed discussion of our methods and findings, we will present an overview of the extant literature followed by a more thorough account of the factors that may influence public concern about climate change by political party.

1 Public opinion regarding climate change

A great deal of research has examined the determinants of individual beliefs regarding climate change. Much of this scholarship has borrowed heavily from psychology and social psychology and, as such, has sought to determine which factors influence *individual* beliefs,

knowledge, and action regarding climate change (Marquart-Pyatt et al. 2011; Shwom et al. 2015). While informative, there have been several critiques of this approach. In particular, these studies tend to ignore the social antecedents and the external determinants of attitudinal variation (Shove 2010). This means that the origin and maintenance of the values that drive views remains largely unexplained. This issue was noted in a recent review of individual-level analyses of public opinion on climate change conducted by Capstick et al. (2015). In their study, Capstick and colleagues note that "Whilst these types of analyses (i.e. individual-level) are useful for explaining the determinants of, and variability in public perceptions, they are however unable to account for movements in aggregate opinion over time which are influenced by broader sociocultural and political factors … a collective level analysis is more appropriate for understanding changes in public opinion over time." (pg. 55). We follow this guidance here by adopting a macropolitical perspective to conduct an examination of interacting social processes that drive *aggregate* public opinion regarding climate change. Thus, the focus is not on assessing individual-level explanations about concern over climate change, but on the system level dynamics that may help us account for changes in national-level public opinion for members of each of the two main political parties in the USA.

A growing body of literature has analyzed aggregate shifts in partisan public opinion on climate change. At least three important studies have emerged from this research. First, drawing on 10 years of Gallup polling data, McCright and Dunlap (2011) reported a rather strong association between polarization on climate change among members of Congress and party divisions about the issue among the public. Again examining trends identified in three Gallup surveys (1990, 2000, and 2010), Guber (2013) identified an growing partisan divide on a whole array of environmental issues, including climate change. While informative, these studies are limited in that they rely solely on information from a single public opinion polling firm and, more importantly, do not include measures of any factors that are believed to impact concern over climate change, such as scientific information, extreme weather, or media coverage. Thus, while these two studies make an important contribution to our understanding of climate change concern by identifying the partisan divide on climate change, they are unable to empirically demonstrate *why* such a divide exists.

Finally, Robert Brulle and colleagues (2012) employ a sophisticated statistical approach to examine shifts in overall climate change concern. Using an algorithm designed by political scientist James Stimson, they combined many public opinion polls administered by several polling agencies that asked about climate change into a single, quarterly measure of public opinion on this issue. With this aggregate measure of public concern about climate change, Brulle at al. could assess the influence of several factors including media coverage, extreme weather events, and several other potentially important control variables on the public's mood concerning climate change. Among other things, they demonstrate the important role that elite cues from politicians and economic factors play in shaping aggregate opinions about climate change. That said, they did not find strong statistical support for a unique media effect in this issue, claiming that the null finding may be due to the small number of cases available for analysis at the time of their study. Beyond having a short series to statistically assess, this paper did not analyze shifts in concern about climate change by political party. Instead, the authors focus exclusively on overall shifts in public concern. The goal of the present study is to build on this prior work by assessing a series of factors that theory and prior research have shown may influence aggregate, public concern over climate change, and to gain a better understanding of the factors that have led to the overall partisan divide on the issue. We outline the factors that may influence public concern about climate change below.

1.1 Determinants of aggregate shifts in public opinion on climate change

Since this is the first examination of national-level shifts in *partisan* concern about climate change, we adopt an exploratory approach in this analysis. We focus on four key factors largely established by previous scholarship examining *overall* national-level shifts in public concern about this issue. Additionally, because work in the field of communications has developed several theories that may help us explain why partisans may consume media messages differently, we pay close attention to how partisan media may influence partisan shifts in concern about climate change.

1.1.1 Level and nature of media coverage

An extensive body of literature (Dumitrescu and Mughan 2010; Zaller 1992) has shown that public opinion on certain issues is significantly impacted by both the frequency and prominence of related media coverage. However, frequency, prominence, and framing vary widely on some issues, in part, due to the partisan nature of contemporary media. This present phenomenon and the extent to which media markets are geared towards audience preferences have been well established by communication scholars (e.g., Feldman et al. 2015). These studies provide important guidance about how partisan media may influence public opinion about climate change by party, demonstrating that partisan media tends to reinforce and solidify the pre-existing worldviews of audience members who share the partisan slant of the media outlet (AKA "The Echo Chamber" see Jamieson and Cappella 2008). However, when the audience is presented with messages conflicting with their previous notions, they tend to reject the messages and intensify their pre-existing beliefs. The latter effect is commonly referred to as the "hostile media" effect (Sellers 2010; Stroud 2011, Gunther and Schmitt 2004).

Zhou (2016) extends the hostile media effect by suggesting individuals with strong prior beliefs may be "goal oriented" such that they engage in "motivated reasoning" which may lead them to ignore or reject divergent views. Per Zhou, a principle source of motivated reasoning is party identification and political ideology. Consequently, strong partisans often do not behave according to traditional expectations of political behavior, particularly in how they process opposing political frames. Zhou also points out that when motivated reasoners are exposed to opposing views, particularly about highly polarized political issues, the result may be to further intensify their pre-existing views (what Zhou and others have called the "boomerang" effect). Zhou provided strong empirical support for such an effect. His experimental research showed that when Republicans are exposed to information advocating for increased attention to climate change, their support for action declined and their overall skepticism of climate change actually grew.

These media effects are particularly relevant here because coverage of climate change in the partisan media is significantly different depending on the partisan slant of the outlet. In fact, scholars have demonstrated that conservative media has spread doubt among their largely conservative audiences about the reality of climate change in large part by calling into question the trustworthiness of climate scientists and their research (Dunlap and McCright 2011; Leiserowitz et al. 2010). Other scholarship has found that watching Fox News, for instance, was correlated with lower levels of acceptance of climate science, while watching MSNBC was associated with greater acceptance of the relevant scientific evidence (McKnight 2010).

If the above arguments can help explain reception to media coverage about climate change, the following four hypotheses can be established. First, when Republican-leaning media outlets increase coverage of climate change, we should expect Republicans to have lower

levels of overall concern about climate change (i.e., the "echo chamber" effect). When progressive media outlets cover the issue, Republicans should be significantly less inclined to be concerned about the issue ("hostile media" or "boomerang" effects). Conversely, Democrats should not only be more concerned about climate change as moderate-to-liberal media outlets increase coverage about the issue (i.e., echo chamber effect) but also when Republican media outlets cover it more (i.e., hostile media or boomerang effect). Note that while we fully acknowledge that media segmentation (i.e., individuals will avoid news outlets that do not confirm their already existing beliefs (Wolfe et al. 2013: 185)) exists and has been well documented (e.g., Jamieson and Cappella 2008), Figure S-1 in our supplemental material clearly demonstrates that such an effect is far from being complete. There is no prior work that examines how relatively moderate media outlets such as CNN or network televisions (i.e., ABC, CBS, NBC) might affect partisan audiences differently. We will explore these effects in our models but have no expectation for the direction of association.

Finally, several studies have examined the impact of late night comedy shows on overall climate change concern, especially *The Daily Show* and *The Colbert Report* (e.g., Brewer and McKnight 2015). These shows tend to be more progressive and the audience tends to lean Democratic. In this analysis, we will assess the possibility that these comedy shows influence concern about climate change among Democrats and/or Republicans in ways similar to other progressive media outlets.

1.1.2 Extreme weather events

Another major factor believed to increase public concern over climate change is the occurrence of "focusing events" in the form of extreme weather events (Weber and Stern 2011). Focusing events are unusual or novel occurrences that are unexpected and garner immediate attention (Birkland 2006). In many cases, these focusing events result in shifts in media attention to new areas or to new perspectives on an existing public issue. If this occurs, it resets the media agenda and can lead to increased coverage of the issue (Wolf et al. 2013: 180). Extreme events, such as Hurricane Katrina, the long-term drought in California, or dramatic shifts in temperature or precipitation, may constitute focusing events that increase levels of coverage of climate change and, thus, possibly lead to shifts in public concern over climate change (Marquart-Pyatt et al. 2014).

Empirical evidence supporting an association between extreme weather and public concern about climate change has been rather mixed. Several studies, mostly examining conditions at the local level, have shown that weather extremes including high temperature (Shao et al. 2014), floods (Spence et al. 2011), hurricanes, winter warming in snow country, and droughts (Hamilton et al. 2013) have been associated with greater concern about climate change. Other studies, however, have cast doubt on this relationship. McCright et al. (2014), for instance, found that local temperature anomalies were not attributed to global warming. Of particular importance given our focus here on partisan differences in concern about climate change, two recent papers (Marquart-Pyatt et al. 2014, McCright et al.2014) examined the role of weather anomalies on individuals accounting for political orientation and found that political ideology exercises a dominant influence on the perception of climate change and far eclipses the influence of weather events. In any case, it remains empirically untested whether a localized weather event is capable of shifting aggregate public concern about climate change for members of either political party. Since our media measures are national in scope, we do not examine local media effects. We acknowledge, however, that an aggregate influence would likely manifest through media coverage of the extreme weather.

1.1.3 Lack of scientific literacy

An often cited explanation for the lack of public concern regarding climate change is limited scientific climate change literacy among the general public (Bauer et al. 2007). Based on the notion of an information deficit, this approach assumes that information provision will increase levels of public understanding and thus concern over climate change (Stoknes 2014). What the claim fails to consider is the role that conservative media has played in promulgating the notion that science, in general, and climate scientists, in particular, are not trustworthy (Dunlap and McCright 2011). If this is the case, we should expect the dissemination of climate science to influence the opinions of Democrats and Republicans in different ways. For Democrats, this should increase concern due to "echo chamber' effects and decrease concern for Republicans due to "hostile media" effects.

Perhaps the key events regarding the promulgation of scientific information about climate change are on the issuance of major scientific studies, such as the 6–7-year cycle of IPCC reports or the release of the quadrennial US National Climate Assessments (NCA) by the US Global Change Research Program. When these reports are released, they are widely covered in the media and offer the most recent science related to climate change. These reports are believed to provide an important link between the scientific communities' understanding of climate change and how the public views this issue. Additionally, Zhao et al. (2011) has shown that science-based news delivered through popular scientific magazines designed for a more general audience has a positive impact on individual concern and knowledge about climate change among readers of those magazines. However, Brulle et al. (2012) found no direct impact on public impact from the provision of scientific information at the aggregate level. To assess the possibility that the influence of scientific information on public concern varies by political party, we examine the potential influence of this factor separately for Republicans and Democrats. Because of the attack on science by Republican media, we would expect science to be negatively correlated with climate concern for Republicans and the reverse for Democrats, as they are likely more receptive to scientific information.

1.1.4 Shifts in macroconditions

Finally, environmental issues, broadly, and climate change specifically, are consistently ranked as a relatively low priority by members of the public when compared to several other issues such as economic conditions or military conflict. An analysis conducted by Kahn and Kotchen (2010), for instance, found that fluctuations in the business cycle substantially influence levels of environmental concern. Scruggs and Benegal (2012) found that concern about climate change decreased during times of unemployment. Likewise, increases in unemployment and lower levels of income were both negatively associated with public concern regarding the environment. Additionally, external political conditions, especially armed conflict, shift attention to foreign affairs and away from internal concerns (Gelpi et al. 2009). Thus, these factors are treated as control variables in the analysis to ensure that their influence is examined and to see if they have a unique influence by political party affiliation.

2 Data and methods

2.1 Analysis

To estimate the determinants of over-time shifts in aggregate public concern about climate change by political party, we develop a quarterly time-series from 2001 to 2014. While the

quarterly time series used here represents a substantial improvement over that used in previous scholarship, statistical limitations remain. In particular, having just 54 cases (number of quarters in the series minus 2 because the data was first differenced) offers us little flexibility in the estimation techniques we can employ and substantially restricts the number of explanatory variables we can consider in any given statistical model. To overcome this limitation, we opt to assess a series of restricted models broken into small but related blocks rather than assessing a single, exhaustive model. This approach improves the robustness of our results by reducing the risk that our point estimates will be degraded by a limited number of cases.

2.2 The dependent variable

Following Brulle et al. (2012), we constructed two longitudinal measures of public opinion on climate change (one each for Democrats and Republicans) by applying James Stimson's algorithm (1999) to polling questions asking respondents about their beliefs on climate change between 2001 and 2014 (see supplemental material for a list of all questions related to climate change we included in our analyses). The algorithm allows us to construct a single time series of public mood on climate change by aggregating multiple survey questions (22) from several different polling agencies (14) in 145 separate polls into a single "policy mood" score. This aggregate index is then used to gauge overall shifts in public mood more accurately than could be done with the limited, sporadic results from a single survey. Separate polling results for both political parties were then entered into Stimson's WCALC program (http://stimson.web.unc.edu/software/), which produced a quarterly metric between 2001 and 2014. Because we largely replicate Brulle et al.'s (2012) approach when constructing the dependent variable, we label this measure the Climate Change Threat Index (CCTI).

2.3 Independent variables

We constructed a quarterly database that includes all of the theoretically derived explanatory variables that may help explain changes in partisan public opinion. The specific sources for all measures in our study are included in the supplemental analysis available online. To gauge the influence of media on the opinion shaping process, we assessed the influence of several types of media, including the number of articles related to climate change in the New York Times (NYT) and Wall Street Journal (WSJ), as well as television coverage of the issue on a number of channels including ABC, CBS, NBC, PBS, CNN, MSNBC, and FOX news, as well as the late night comedy shows The Colbert Report and The Daily Show. Finally, the influence of radio coverage of climate change was assessed with the count of climate change stories covered by Rush Limbaugh and NPR.

We gauge the potential influence of scientific information with two separate indicators. The first is the count of climate-related stories in over a dozen popular scientific magazines such as National Geographic and Scientific America (see supplemental material for a list). We also include a dummy variable coded "1" in quarters when a major climate assessment report was released (IPCC, NCA, etc.). Localized weather extremes were assessed with two separate indicators. The first captures quarters where a hurricane made landfall on the continental USA. We also assess the possible influence of other extreme weather events using the weather extreme index created by NOAA (again, see supplemental material for details about the index). Finally, we assess our control variables using three separate indicators. The overall strength of the economy was measured using both the GDP and the unemployment rate, and we gauge the potential influence of the intensity of ongoing armed conflict using the number of US military war deaths in Iraq and Afghanistan.

3 Results

3.1 Trend information

Figure 1 presents the CCTI for self-identified Republicans and Democrats between 2001 and 2014. Here, we clearly see that the gap in concern about climate change between Republicans and Democrats has grown substantially during this period, with Republicans increasingly less concerned about the issue while Democrats have become increasingly more concerned. While the sizable partisan gap illustrated in the figure has been well documented in the literature (e.g., McCright and Dunlap 2011; Guber 2013), what has been ignored is why such divergence has taken place. The multivariate analysis presented below is intended to shed light on this largely unanswered question.

Table 1 presents findings from our regression models. The models described below focus on assessing the effect that partisan media coverage of climate change may have on partisan public opinion. We borrow heavily from the prior research in the field of communications outlined. In particular, an essential component of this exercise is to determine if a partisan audience responds in ways similar to those described by communication scholars (e.g., Zhou 2016; Sellers 2010; Jamieson and Cappella 2008). Despite some limitations, results from these models should offer insights into the growing partisan divide on climate change. Note that we present standardized regression coefficients to aid in interpretation and to establish an indicator of the magnitude of the effect for each variable.

Model 1 examines the influence of partisan coverage of climate change in two major print media outlets (NYT and WSJ) to see if such coverage can help explain levels of public concern about climate change and to see if such influences are distinct for members of both major political parties. Previous scholarship has demonstrated that news stories covering issues related to climate change in the NYT largely accept anthropogenic climate change and call for action, whereas those in the WSJ tend to be much more skeptical about climate change (see Feldman et al. 2015). Given that the two newspapers present opposite frames about climate change, the communication scholarship outlined above would suggest that readers will
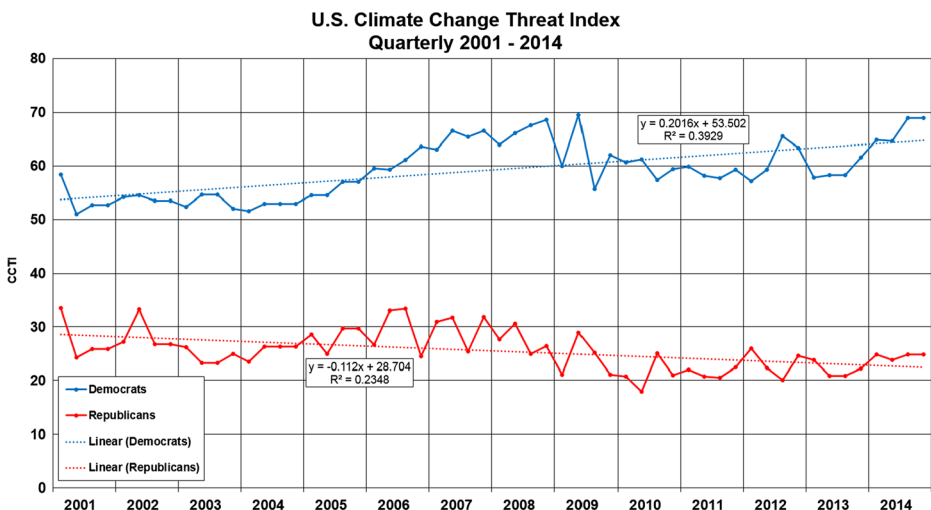
Fig. 1 Climate Change Threat Index (CCTI) by political party, 2001–2014

Table 1 Standardized regression estimates predicting CCTI by self-identified political party

	Model 1		Model 2		Model 3		Model 4	
	Dem	Rep	Dem	Rep	Dem	Rep	Dem	Rep
Newspaper stories								
# NYT Stories on CC	.59***	.11	–	–	–	–	–	–
# WSJ Stories on CC	.17	−.13	–	–	–	–	–	–
Network television coverage								
# of CC stories on Network TV	–	–	.11	.74***	–	–	–	–
# of CC stories on PBS	–	–	.54***	−.74***	–	–	–	–
Cable television coverage								
# of CC stories on MSNBC	–	–	–	–	.05	.08	–	–
# of CC stories on Colbert Report and Daily Show	–	–	–	–	.24	−.36**	–	–
# of CC stories on CNN	–	–	–	–	.16	.32*	–	–
# of CC Stories on Fox News	–	–	–	–	.35	−.01	–	–
Radio coverage								
# of CC stories Rush Limbaugh	–	–	–	–	–	–	.39***	−.24**
# of CC stories NPR	–	–	–	–	–	–	.51***	.25
Constant	.05	.05	.10	.14	−.01	.01	.10	.06
# of cases (quarters)	54	54	54	54	54	54	54	54
R2	.54	.01	.51	.24	.35	.25	.49	.10
	Model 5		Model 6		Model 7			
	Dem	Rep	Dem	Rep	Dem	Rep		
Scientific information								
Scientific mags stories on CC	.42**	−.01	–	–	–	–		
Major CC reports	.05	−.04	–	–	–	–		
Extreme weather								
Weather index	–	–	−.08	−.43***	–	–		
1 = hurricane	–	–	.01	−.00	–	–		
Structural conditions								
GDP (2009)	–	–	–	–	.68***	−.13		
Unemployment rate	–	–	–	–	−.13	−.63***		
War deaths	–	–	–	–	.03	.10		
Constant	.10	.06	.19	.18	.09	−.01		
# of cases (quarters)	54	54	54	54	54	54		
R2	.17	.00	.01	.18	.41	.52		

All models corrected for heteroskedasticity. All models correct for stochastic trends (unit root) by first differencing all variables in the equation. Standardized regression coefficients are reported for ease of comparison. All significance levels based on two−tailed tests

*$p > .05$; **$p > .01$; ***$p > .001$

respond positively to media messages that are consistent with their preconceived notions on the issue (i.e., the "echo chamber" effect) while those exposed to messages that run counter to their beliefs will not only reject the message but also reinforce and strengthen their pre-existing view (i.e., the "hostile media" or "boomerang" effects).

Results from model 1 provide at least some support for such claims. The findings show that Democrats are significantly more concerned about climate change when coverage of the issue increases in the NYT but are not affected by coverage in the WSJ. This is consistent with an "echo chamber" argument. All other results from model 1, however, do not reach statistical significance. It is noteworthy, though, that a single media outlet (NYT) accounts for 54% of the variation in concern about climate change among Democrats. This level of explained variation is higher than any other set of indicators we assess, suggesting that NYT coverage of the issue is the most powerful factor affecting concern among Democrats. Republicans, however, do not appear to be influenced by coverage of this issue in either the NYT or the WSJ.

Model 2 assesses the influence of network TV news coverage of climate change. We see from the results that coverage of the issue on network television (ABC, CBS, NBC) does not influence opinions of Democrats but does increase concern about climate change among Republicans. Nothing in the communication literature would have led us to anticipate this outcome but it seems at least plausible that because network television may be *relatively* less partisan (when compared to cable news), coverage of climate change on network television may be less likely to produce a "hostile media" effect and instead provides an opportunity for Republicans to reassess their position on the issue. As polling information continues to accumulate over time allowing for more sophisticated statistical modeling, future scholarship should explore this possibility further. The findings related to PBS in model 2 do, however, provide results much more in line with our expectations. As a more progressive television network, coverage of climate change on PBS likely acknowledges its existence and supports action. The findings show that increased coverage of climate change on this network is associated with a significant increase in concern about the issue for Democrats ("echo chamber"—e.g., Jamieson and Cappella 2008) but significantly *less* concern among Republicans ("hostile media" effect—e.g., Zhou 2016; Sellers 2010).

Model 3 presents the findings regarding the influence of cable news coverage of climate change. Here, we see that coverage of the issue on cable television does not influence Democrats' views on climate change at all. Concern among Republicans is also not significantly affected by most cable news coverage of the issue. A couple of exceptions exist. First, Republicans who claim to regularly watch *The Daily Show* or *The Colbert Report* are significantly *less* likely to believe in anthropogenic climate change. Again, this may be a function of the "boomerang" effect described by Zhou (2016). Republicans do, however, appear to be responding positively to climate change coverage on CNN. Much like the findings related to the influence of network television coverage of the issue on Republicans, it seems plausible that a Republican audience watching this channel perceives it to be less politically biased than other media outlets and is therefore less inclined to respond in a "hostile" manner to the messages.

Our final media model examines the influence of radio coverage of climate change. Here, we assess the potential contribution to climate change concern that is a function of coverage of this issue on Rush Limbaugh's radio show (conservative), as well as on NPR (progressive). The results from this model provide the most consistent support for our expectations. Echo chamber effects are supported by members of both parties. When Rush Limbaugh spends more airtime discussing climate change, Republicans are significantly *less* concerned about the issue. Similarly, increased coverage of climate change on NPR is *positively* related to concern about the issue for Democrats. Expectations for a "hostile media" effect are also offered some support. Increased coverage of climate change by Rush Limbaugh *increases* concern about the issue among Democrats. While counterintuitive, this finding is consistent with the "hostile media" effect described by Sellers (2010).

Model 5 examines the role that the dissemination of science may have on climate change concern. Despite claims to the contrary (e.g., Stoknes 2014), greater frequency of relevant science does not appear to be influencing all members of the public equally. In fact, our results suggest that scientific dissemination in neither popular magazines nor major climate reports has any influence on the opinions of Republicans. This finding is not surprising given what we know about those who are more likely to consume conservative media. Hmielowski et al. 2014, for instance, have shown that conservative media use decreases trust in scientists which, in turn, decreases certainty that climate change is happening and/or that the consequences are real. Conversely, they show that those more inclined to watch non-conservative media have increased trust in scientists and are therefore more

likely to believe anthropogenic climate change is a reality. Our findings are consistent with such a claim as we see that Democrats are positively influenced by coverage in popular scientific magazines. It is important to point out, however, that the release of major climate change reports (e.g., IPCC, NCA) appears to have no influence on overall levels of concern among members of either political party. It may be that because these reports are not readily digestible by the general public, they rely instead on journalistic interpretations of the issue in popular magazines. In any case, these findings shed light on why dissemination of scientific information will likely play only a minor role in convincing individuals that climate change is happening, particularly because Republicans do not appear to respond to science production on the issue. Additionally, these results challenge assumptions that increasing access to scientific information will influence overall public opinion.

Model 6 assesses the rather widely held view among scholars that extreme weather events can influence public opinion about climate change. Contrary to scholarly claims (e.g., Konisky et al. 2016), extreme weather events do not influence aggregate public concern about climate change among Democrats. Republicans, however, do appear to respond to extreme weather, but in rather unexpected ways. The results suggest that when a greater share of the country is experiencing extreme weather, Republicans are *less* likely to believe in climate change. This is certainly not consistent with previous work but it seems at least plausible that during extreme weather events, media coverage of the events may link weather patterns to climate change. If that is the case, results from previous models would suggest that Republicans may harden their views against climate change during periods with extreme weather. Unfortunately, the small number of cases in our sample does not allow us to simultaneously test media effects and weather in the same model, which would allow us to assess this possibility. In any case, the null findings for weather among Democrats and the lack of concern due to hurricanes among Republicans suggest that extreme weather will likely not produce a sizable shift in national-level public opinion about climate change. This is likely the case because such events will typically only effect opinions in the locales directly affected by the extreme weather events.

The final model assesses the influence of structural shifts, particularly economic conditions and war deaths in Afghanistan and Iraq. Results for Democrats show that the only GDP has a significant influence on their beliefs. This suggests that when the economy is doing well (i.e., a growing GDP), Democrats are more likely to express concern about climate change. Findings for Republicans are consistent with those of Scruggs and Benegal (2012) who found that public concern about climate change decreased when unemployment rates are high. Importantly, no other model accounts for more explained variation in the outcome for Republicans.

4 Conclusion

In this analysis, we set out to assess the explanatory power of a set of factors that may help explain the growing partisan divide in aggregate public concern over climate change. Findings from our longitudinal analysis provided at least some evidence that partisan media plays a role in driving concern about this issue in ways consistent with expectations derived from the field of communications. The findings offer tentative support for both "echo chamber" effects and "hostile media" or "boomerang" effects. Several tests of media effects in our models show that media outlets are able to strengthen views held by their audiences when the framing is consistent with the audiences' pre-existing beliefs. Such findings lend support to claims about "echo chamber" effects advanced by communications scholars. Additionally, some results suggest that when media outlets present the audience with frames about climate change in

ways that are not consistent with their pre-existing notions, rather than possibly reevaluating and updating their beliefs about the issue, they appear to strengthen their views. This effect is consistent with "hostile media" or "boomerang" effects (Zhou 2016) in which audiences are said to reject coverage that is inconsistent with their views, *especially when they see such coverage as politically biased*. But what happens when the coverage is presented by a more moderate media outlet? Prior research has not offered much guidance here but the results from the present study offer some insight that future scholarship should explore further. Some results show that when *relatively* moderate television networks (specifically network television and CNN) increase coverage of climate change, there is an associated increase in concern about climate change among Republicans. While we cannot make definitive claims, it seems plausible that when coverage of climate change is presented on more politically neutral channels, Republicans may be open to reconsidering their positions rather than respond in ways consistent with a "hostile media" effect.

Beyond isolating important media effects, the analysis also assesses several additional factors that previous scholarship suggests should influence public concern about climate change. Despite expectations from previous scholarship, the dissemination of scientific information only increases concern about climate change among Democrats. Republicans, on the other hand, do not appear to be persuaded by the availability of scientific information on the issue. Additionally, local and regional weather extremes do not appear to have a measurable impact on aggregate concern about climate change among Democrats and, surprisingly, Republicans appear to grow *less* concerned about the issue during periods of extreme weather. The latter may be understood as a "hostile media" effect (i.e., extreme weather may produce more media coverage supporting climate change action that Republicans respond negatively to). Specific testing of these possibilities will be more feasible as polling information on climate change continues to accumulate. Finally, macroeconomic conditions appear to influence concern about climate change for members of both political parties, but in somewhat different ways. During periods of economic expansion, Democrats grow more concerned about climate change. Republicans are significantly less concerned about climate change when unemployment rates are higher. These findings suggest that both Republicans and Democrats will be less concerned about climate change during periods of economic weakness.

These findings improve our understanding of the growing partisan divide on climate change. There are, however, several limitations of the study that future scholarship will need to address. First, the short time frame of analysis and number of cases limit the statistical strength of the analysis. Because surveys about beliefs in climate change are sparse prior to 2001, it is not possible to develop a longer time series analysis. This can only be remedied through the inclusion of more surveys over time. Such a limited time series severely constrains estimation options and the sophistication of the models we can consider. We were not able, for instance, to test a simultaneous model of all factors in our model, nor were we able to assess interaction effects because both would demand more degrees of freedom. Conducting statistical analyses with such a small number of cases may also explain the null findings we see here. As polling about climate change concern continues into the future, some of these factors may prove to have an impact on public concern about climate change. Secondly, the analysis does not take into account the well-documented variability in audience exposure to different media outlets. Studies have shown that the general public prefers to consume media that is consistent with their partisan identity (see Sellers 2010; Stroud 2011), and that individuals will avoid news outlets that do not confirm their already existing beliefs (Wolfe et al. 2013: 185). Our analyses were not able to account for this possibility. However, Figure S1 in our

supplemental material shows that audience segmentation is not complete, as members of each party consume virtually all media sources. Future scholarship examining aggregate shifts in climate change concern should consider segmentation effects to determine how they may alter media influences on concern about this issue. Our study was also limited by the fact that we do not consider precise measures of the content of climate change coverage in our media measures. Instead, we rely heavily on prior work that has done content coding of a number of the media outlets we assess here. Future work should consider expanding content coding of climate change coverage to more media outlets. Finally, a great deal of attention has been given to the rise of "fake news" and the potential influence such misleading information may have on shaping public opinion on a number of issues including climate change. While there is ample anochdotal evidence that fake news is being released to mislead the public, no comprehensive information on the dissemination of fake news specifically related to climate change currently exists. As more information on the dissemination of fake news becomes available, scholars should assess its influence on concern about climate change.

The most practical implication of this study is that it points to the dominant factors driving the growing partisan divide on climate change. In particular, the findings point to the powerful role that partisan media plays in reinforcing and strengthening opposition or support of climate change action. This would imply that to have appreciable shifts in aggregate public concern over climate change, the level, nature, and audience reach of media coverage would need to significantly shift. It also implies that the communications strategies focused on individual persuasion and information provision will likely be unsuccessful (Dunlap et al. 2016).

References

Bauer M, Allum N, Miller S (2007) What can we learn from 25-years of PUS research? Liberating and expanding the agenda. Public Underst Sci 16:79–95

Birkland TA (2006) Lessons of disaster: policy change after catastrophic events. Georgetown University Press, Washington, DC

Brewer PR, McKnight J (2015) Climate as comedy the effects of satirical television news on climate change perceptions. Sci Commun 37(5):635–657

Brulle RJ, Carmichael JT, Jenkins JC (2012) Climate change and public concern: 2002–2010. Clim Chang 114:169–188

Capstick S, Whitmarsh L et al (2015) International trends in public perceptions of climate change over the past quarter century. Wiley Interdiscip Rev Clim Chang 1:35–61

Cook J, Nuccitelli D, Green SA, Richardson M, Winkler B, Painting R, Way R, Jacobs P, Skuce A (2013) Quantifying the consensus on anthropogenic global warming in the scientific literature. Environ Res Lett 8: 1-7

Dumitrescu D, Mughan A (2010) Mass Media and Democratic Politics. In: Leicht K, Jenkins JC (eds) The handbook of politics: state and civil society. Global Perspective Springer Publishers, New York, pp 477–491

Dunlap RE (2013) Climate change skepticism and denial: an introduction. Am Behav Sci 57:691–698

Dunlap RE, McCright AM (2011) Organized climate change denial. In: Dryzek J, Norgaard R, Schlosberg D (eds) Oxford handbook of climate change and society. Oxford Press, Cambridge, pp 144–160

Dunlap RE, McCright AM, Yarosh JH (2016) The political divide on climate change: partisan polarization widens in the U.S. Environ: Sci Policy Sustain Dev 58:4–23

Feldman LP, Hart PS, Milosevic T (2015) Polarizing news? Representations of threat and efficacy in leading U.S. newspapers' coverage of climate change. Public Understand Sci 1–17

Gelpi C, Feaver P, Reifler J (2009) Paying the human costs of war: american public opinion and casualties in military conflicts. Princeton University Press, Princeton

Guber DL (2013) A cooling climate for change? Party polarization and the politics of global warming. Am Behav Sci 57(1):93–115

Gunther AC, Schmitt K (2004) Mapping boundaries of the hostile media effect. Journal of Communication 54: 55–70

Hamilton LC, Stampone M (2013) Blowin' in the wind: short-term weather and belief in anthropogenic climate change. Weather, Climate, and Society 5:112–119

Hmielowski JD, Feldman L, Myers TA, Leiserowitz A, Maibach E (2014) An attack on science? Media use, trust in scientists, and perceptions of global warming. Public Underst Sci 23(7):866–883

Jamieson KH, Cappella JN (2008) Echo chamber: Rush Limbaugh and the conservative media establishment. Oxford University Press

Kahn ME, Kotchen MJ (2010) Environmental concern and the business cycle: the chilling effect of recessions. NBER working paper series. Cambridge, MA

Konisky D, Hughes L, Kaylor C (2016) Extreme weather events and climate change concern. Clim Chang 134: 533–547

Leiserowitz A, Maibach E, Roser-Renouf C, Smith N (2010) Climate change in the American Mind: Americans' global warming beliefs and attitudes in June 2010. Yale University and George Mason University

Marquart-Pyatt ST, Shwom RL, Dietz T et al (2011) Understanding public opinion on climate change: a call for research. Environment 53(4):38–42

Marquart-Pyatt ST, McCright A, Dietz T, Dunlap R (2014) Politics eclipses climate extremes for climate change perceptions. Glob Environ Chang 29:246–257

McCright A, Dunlap R (2011) The politicization of climate change and polarization in the American public's views of global warming, 2001–2010. Sociol Quart 52(2):155–194

McCright AM, Dunlap RE, Xiao C (2014) Increasing influence of party identification on percieved agreement and support for government action on climate change in the United States, 2006–12. Weather, Climate, and Society 6:194–201

Mcknight D (2010) A change in the climate? The journalism of opinion at News Corporation. Journalism 11(6): 693–706

Scruggs L, Bengal S (2012) Declining public concern about climate change: can we blame the great recession? Glob Environ Chang 22:505–515

Sellers P (2010) Cycles of Spin: Strategic Communication in the U.S. Congress. Cambridge University Press

Shao W, Keim BD, Garand JC, Hamilton LC (2014) Weather, climate, and the economy: explaining risk perceptions of global warming. Weather Clim Soc 6:119–134

Shove E (2010) Beyond the ABC: climate change policy and theories of social change. Environ Plan 42:1273–1285

Shwom RL, McCright AM, Berchin SR (2015) Public opinion on climate change. In: Dunlap RE, Brulle RJ (eds) Climate change and society: sociological perspectives. Oxford University Press, New York, pp 269-299

Spence A, Poortinga W, Butler C, Pidgeon N (2011) Perceptions of climate change and willingness to save energy related to flood experience. Nat Clim Chang 1:46–49

Stoknes PE (2014) Rethinking climate communications and the "psychological climate paradox". Energ Res Soc Sci 1:161–170

Stroud NJ (2011) Niche news: the politics of news choice. Oxford University Press

Weber E, Stern P (2011) Public understanding of climate change in the United States. Am Psychol 66(4):315–328

Wolfe M, Jones BD, Baumgartner FR (2013) A Failure to communicate: agenda setting in media and policy studies. Political Communication 30:175–192

Zaller JR (1992) The nature and origins of mass opinion. Cambridge University Press, New York

Zhao X, Leiserowitz A, Maibach E, Roser-Renouf C (2011) Attention to science/environment news positively predicts and attention to political news negatively predicts global warming risk perceptions and policy support. J Commun 61:713–731

Zhou J (2016) Boomerang versus javelins: how polarization constrains communication on climate change. Environ Politics 25:788–811