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Elite cues, media coverage, and public concern: an integrated path analysis of public opinion on climate change, 2001–2013

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ABSTRACT
To analyze the factors affecting US public concern about the threat of climate change between January 2002 and December 2013, data from 74 separate surveys are used to construct quarterly measures of public concern over global climate change. Five factors should account for changes in levels of concern: extreme weather events, public access to accurate scientific information, media coverage, elite cues, and movement/countermovement advocacy. Structural equation modeling indicates that elite cues, movement advocacy efforts, weather, and structural economic factors influence the level of public concern about climate change. While media coverage exerts an important influence, it is itself largely a function of elite cues and economic factors. Promulgation to the public of scientific information on climate change has no effect. Information-based science advocacy has had only a minor effect on public concern, while political mobilization by elites and advocacy groups is critical in influencing climate change concern.

KEYWORDS US public opinion; climate change; elite cues; media effects; time-series analysis; structural equation models

Introduction

While the scientific consensus regarding climate change has increased, a sizable proportion of the US population does not believe that anthropogenic climate change is happening. Three main explanations have been advanced to account for this. Perhaps the most widely discussed explanation for the lack of belief in or concern about climate change points to political orientations and ideological worldview (Marquart-Pyatt *et al.* 2011, Hamilton *et al.* 2015, Hornsey *et al.* 2016). Other studies have assessed whether or not the nature of media coverage about climate change can explain variation on concern about this issue (Zaller 1992, Tan and Weaver 2009, Hoyos 2014, Capstick *et al.* 2015, Painter and Gavin 2015). Finally, the role of elite cues and public expressions of opinions regarding climate

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change in political discourse is seen as a major influence on public concern regarding climate change (Brulle *et al.* 2012). For the most part, however, the linkages between public opinion on climate change, media coverage, and political discourse remain unexamined.

Here, we seek to unite these three literatures by employing an empirical methodology that will allow us to assess shifts in national-level public opinion about climate change using a macro-political perspective on public opinion. This approach is in distinct contrast to the vast majority of other scholarship on public opinion on climate change, which tends to use individual-level data. Individual-level studies typically rely on approaches derived from communication sciences and social psychology. These studies seek to determine which factors influence individual beliefs, knowledge, and action regarding climate change (Marquart-Pyatt *et al.* 2011). There is an extensive and well-developed literature in this area. A separate research tradition, based in political science, focuses on the dynamics of the formation of aggregate public opinion, and the relationships between the media, public opinion, and political discourse. The focus is not on the individual, but on the system level dynamics in an attempt to explain changes in the overall action taken in regard to a political issue (Erikson *et al.* 2002, p. 1–11). According to this perspective, political discourse and the issue focus of elites are believed to impact public opinion via its influence on the media. As Capstick *et al.* (2015, p. 55) note:

> Whilst these types of analyses (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.

We follow this insight and adopt a macro-political perspective to conduct an examination of interacting social processes that drive aggregate public opinion regarding climate change.

Using a national-level time series database, the study will analyze the structural factors that drive public opinion.[1] Because we have a sufficiently long series, we can use structural equation models (SEMs) to examine the linkages between political discourse, media coverage, and public concern over climate change, as well as inclusion of a number of additional factors believed to influence public concern, including weather events, scientific information, economic shifts, and external political events. We asses these factors to determine if they either directly or indirectly influence public concern over climate change. First, we describe the existing literature on the different factors that influence aggregate climate change public opinion. Based on this literature, we develop a recursive SEM that delineates the

causal paths designated by this literature. Then, we describe the analytic methods and data collection procedures. We then provide the results of the SEM models. We conclude with a discussion of the meaning of this model for climate communication efforts.

Drivers of public concern over climate change

Existing literature has identified four major factors that influence individual level public opinion on climate change. However, since we are examining the formation of public opinion at the aggregate level, we draw upon this literature to test whether these factors impact aggregate public opinion. Since we are examining aggregate public opinion, this does not enable us to speak to any of the factors that may or may not influence individual level dynamics.

One of the major explanations for the lack of public concern regarding climate change is the lack of scientific literacy regarding climate change (Bord *et al.* 2000, Bauer *et al.* 2007). Based on the information-deficit model, the failure of the public to possess a clear understanding of climate science underlies the difference between the scientific and public understanding of it. Several factors, including the inherent difficulty of understanding climate change, the limitations of personal experience, and inappropriate mental models, all combined to limit individual understanding (Weber and Stern 2011). The logical implication of this view is that culturally and socially appropriate messages that properly convey scientific information will result in a shift in public opinion about the threat of climate change (Reynolds *et al.* 2010, Pidgeon and Fischhoff 2011, Sterman 2011). Zhao *et al.* (2011) found that attention to science-based news has a positive effect on individual concern and knowledge about climate change. However, Brulle *et al.* (2012) found no direct impact of scientific information on aggregate public opinion on climate change. However, this analysis did not account for the indirect effect of increasing levels of scientific information on media coverage, and its indirect impact on public opinion. This study overcomes this limitation by examining the indirect impact climate science may have via media coverage. The key question is whether changes in the overall availability and promulgation of scientific information via media are sufficient to significantly impact levels of aggregate public concern.

A second commonly mentioned factor is the influence of extreme weather events on concern over climate change (Weber 2011). This approach theorizes that perceptions of the seriousness of climate change are related to individual's personal experiences. Those individuals experiencing the adverse effects of climate change would be more likely to show higher levels of concern. Li *et al.* (2011) show that the impact of

temperature on public concern over climate change is a form of attribute substitution, in which individuals with low levels of partisanship and limited knowledge of climate change use the immediate outside temperature on which to base their opinion on climate change. To date, empirical evidence assessing the relationship between extreme weather conditions and beliefs about anthropogenic climate changed is mixed. Several studies have shown that increasing temperatures or local weather (Krosnick *et al.* 2006, Egan and Mullin 2012, Hamilton and Lemcke-Stampone 2013, Howe *et al.* 2013, Brooks *et al.* 2014, Shao *et al.* 2014), floods (Spence *et al.* 2011), and other extreme events such as hurricanes, winter warming in snow country, and droughts (Hamilton and Keim 2009, Borick and Rabe 2010, Hamilton *et al.* 2013) are associated with increased salience of climate change. Other studies, however, have painted a more nuanced picture of this relationship. Deryugina (2013) found that while there was no relationship between short-run temperature fluctuations (<2 weeks) and climate change beliefs, longer run fluctuations (1 month to 1 year) are significant predictors. Others find little or no relationship between weather and belief in anthropogenic climate change. Marquart-Pyatt *et al.* (2014) and McCright *et al.* (2014) incorporate weather anomalies and individual political orientation and show that political orientation exercises a dominant influence on the perception of climate change and far eclipses the influence of weather events. Translating this to the aggregate level of public opinion shifts the question to whether any given weather events can impact public concern across the entire United States. While analyses have shown temporary impacts at a small state level (Hamilton *et al.* 2105), the question addressed here is whether any of the weather events or conditions have been able to shift the views of a significant portion of the US population to have a significant impact on aggregate levels of concern.

Additionally, weather events are seen to exercise an indirect effect via shifts in media coverage, and thus potentially impact aggregate public concern over climate change. Extreme events may constitute focusing events that increase levels of coverage of climate change, and thus possibly lead to shifts in public concern over climate change. Second, shifts in temperature have been correlated with increased editorial commentary on climate change, which indirectly impacts public concern (Donner and McDaniels 2013).

The third major factor influencing public opinion about climate change is the influence of political discourse, which takes the form of elite cues that shape media coverage. In this approach, members of the public use media coverage to gauge the positions of political elites that they trust and identify with due to their party and ideological identification and form their opinions based on these signals (Lenz 2009). The media-indexing hypothesis (Bennett 1990) shows that because media is dependent on government and

official sources for information, the focus and framing of a particular issue in the media generally follows the extent and range of opinions expressed in official circles. In an extensive analysis, Habel (2012, p. 271) finds that media coverage largely is reactive to the statements of political elites, and that there is minimal effect of media coverage on elites themselves. Support for this perspective has been found regarding media coverage of environmental issues (Yin 1999). Elite cues can override valid scientific information. Darmofal (2009, p. 392) concluded that 'When political elites offered dubious policy cues, many citizens followed these cues rather than rejecting them in favor of more valid cues from opposition elites.' In this vein, several studies have found that more educated and politically active individuals are better able to discern rival partisan positions; hence, their individual attitudes about climate change are more closely synchronized with those of their party leadership (Kellstedt *et al.* 2008, Malka *et al.* 2009, Borick and Rabe 2010, Hamilton 2010, Hamilton and Stampone 2014).

There is no dispute that over the past four decades, the major political parties have gone from consensus to polarization on the issue of climate change (Shipan and Lowry 2001, Lowry 2008). Both Guber (2013) and Dunlap and McCright (2011) find a strong association between political polarization in Congress and polarization in US public opinion about climate change. However, there is no empirical analysis that ties measures of political polarization directly to shifts in public opinion. Brulle *et al.* (2012) provide empirical evidence that elite cues from members of Congress directly impact levels of concern in the US public about climate change. Since individuals rarely have direct access to elite cues (such as press releases or statements on the floor of Congress), media coverage operates as an intervening conduit that carries the elites positions to individuals. Brulle *et al.* (2012) did not model the process by which elite cues are transmitted through the media to inform and shape public opinion. So, while this analysis is suggestive, it does not fully model the process of public opinion formation at the aggregate level (Gamson and Wolfsfeld 1993, Andrews and Caren 2010). To extend this analysis, we examine the process by which elite cues are transmitted and diffused via media coverage, and how media coverage then impacts aggregate public concern about climate change.

An additional dimension of political discourse is the efforts of different advocacy groups. Advocacy groups expend a great deal of effort to influence public opinion on climate change, either indirectly through influencing the amount and nature of media coverage or directly through the provision of information to members or the public (Gamson *et al.* 1992, Barker-Plummer 1995, Koopmans 2004, Agnone 2007, Brick and Cawley 2008, Andrews 2010, Carmichael *et al.* 2012). While these messages may be persuasive to individuals exposed to them, to impact aggregate public

opinion, they have to shift beliefs in a significant portion of the public to be detectable in the aggregate level of public opinion. Additionally, organizations seek to influence media coverage of climate change. Media coverage has been shown to influence the legitimacy of the issue of climate change to the public and coverage is seen to increase aggregate issue salience (Gamson and Wolfsfeld 1993, Andrews and Caren 2010, Greenberg *et al.* 2011). Here, we seek to measure the levels of advocacy regarding climate change, and to statistically assess the impact of these efforts both directly on aggregate public opinion and its indirect effect via media coverage.

The fourth factor we examine is media coverage. In general, media functions as a link between external events and collective perceptions (Capstick *et al.* 2015). Since most individuals do not have direct exposure to political elites or scientific research, their knowledge of climate change is filtered through media coverage (Yin 1999, p. 71). Schäfer *et al.* (2014) show that while increased levels of scientific information and weather events have no impact on media coverage levels, activism raises levels of media coverage. However, their research omitted several important factors, including economic shifts and political discourse by politicians, and has limited utility. This research tests the relative efficacy of all of the major factors hypothesized to influence media coverage, and how media coverage impacts public concern levels.

An extensive body of literature (Zaller 1992, McCombs 2004, Dumitrescu and Mughan 2010) has shown that aggregate public opinion is significantly impacted by the extent and prominence of media coverage. Because many individuals do not possess integrated true attitudes on most issues that are relatively peripheral to their everyday concerns (Zaller 1992), they tend to respond to survey questions based on the most recent information that they have been presented on that issue. The Receive Accept Model has compiled an impressive body of evidence showing that opinions vary widely within the same individuals over time, and that they are primarily based on the latest media presentations on an issue, as well as on ideological cues. Additionally, this research has shown that an individual's education level influences both the attention to news coverage of different issues, and their ability to discern ideological cues.

Thus, the major impact of news media coverage on public opinion is heightened issue salience (Mazur and Lee 1993, Mazur 1998, 2009). The frequency and prominence of a story in media coverage conveys a message to the individual about the relevance of certain issues. Headlines or lead stories further convey the impression that a given issue is important, worthy of an individual's attention. Repeated stories also convey importance. In fact, the frequency of coverage and a story's placement within newspapers matters more than the actual content of reporting in conveying the importance of the issue (Andrews and Caren 2010, p. 843). As public interest in a given issue is driven to higher levels

by media coverage, individuals will then tend to seek out further media coverage of the issue, expanding the level of issue salience (Zhao 2009). Kellstedt (2002) found that elite cues interact with media coverage to shape aggregate changes in racial attitudes. Yin (1999) found that elite cues transmitted via media influenced public concern about environmental issues. Despite this analysis, the question remains about how media coverage is influenced by the external factors listed above, and how these factors in turn drive public concern over climate change. By utilizing a SEM model approach, we will empirically test the influence of these different factors.

Finally, in addition to the four key factors discussed above, it is necessary to account for economic and political factors. Economic factors, including the business cycle (Kahn and Kotchen 2010) and unemployment (Scruggs and Benegal 2012), exert an important influence on environmental concern. Additionally, external political conditions, especially armed conflict, shift attention to foreign affairs and away from internal concerns (Gelpi *et al.* 2009). Thus these control variables must be included in the analysis to ensure that their influence is properly accounted for.

Data and methods

Estimation

To examine the factors that drive over-time shifts in aggregate public concern about climate change, we develop a SEM to predict quarterly shifts in the climate change threat index (CCTI) between 2001 and 2013 (sample size in all models is 52; 4 quarters over 13 years). SEM has long been used in social science research as it is ideally suited for estimating complex causal schemes such as the one we lay out here to predict the level of public concern about climate change (see Acock 2013, Bollen 1989, and Duncan1975 for a thorough treatment of SEM modeling, Fox 2002, Greene 2012). SEM not only allows us to test complex causal structures of longitudinal data but also to systematically investigate mediating effects. These advantages provide important improvements over conventional regression techniques. While traditional OLS assumes that all independent variables have a direct influence on the explanatory variable, SEM allows for multiple pathways operating through intervening variables. Given that our theoretical model posits several independent factors that impact public concern either directly or indirectly through media coverage, SEM is an ideal estimation technique. We estimate our models using a maximum likelihood estimation technique with robust standard errors. All models were estimated using Stata 13.1. Figure 1 presents our theoretical model in graphical form.

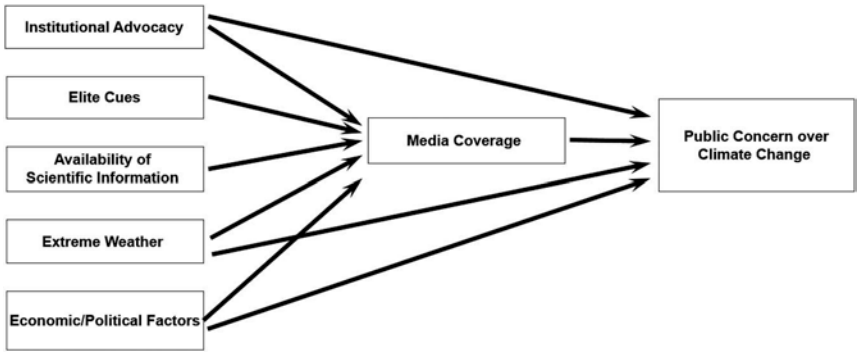

Figure 1. Conceptual scheme – analysis of drivers of CCTI.

Dependent variable – CCTI

Following Brulle *et al.* (2012), we constructed a time-series measure of public opinion on climate change by applying the Stimson algorithm (1999) to polling data on climate change between 2001 and 2013.[2] The algorithm allows scholars to construct a single time series of public mood on an issue by aggregating multiple, individual surveys into a single mood score. This collection of individual surveys into a single aggregated index can then be used to gauge overall shifts in public mood more accurately than could be done with the limited, sporadic data of a single survey.[3] We label this measure the CCTI. This index is based on the analysis of 14 different questions from 6 different polling organizations in 74 surveys, which were administered to 84,086 respondents between 2001 and 2013. These survey questions thus provide a robust sample of all climate change surveys conducted in the United States.

Figure 2 shows shifts in the CCTI between 2001 and 2013. Overall, this graph corresponds well to historical events. As this graph illustrates, concern about climate change was relatively steady until the middle of 2005. Beginning in the third quarter of 2005 until the fourth quarter of 2007, there was a steady and persistent increase in the CCTI. During this same period, there was a bipartisan effort to enact climate change legislation. This coincided with the release of An Inconvenient Truth and the release of the IPCC report in 2007. Beginning in 2008, the level of concern over climate change began to decline. There was one final increase in the CCTI during the second quarter of 2009, which coincided with the Congressional vote on the Waxman–Markey Bill in June of 2009. Levels of concern then declined, aided by the so-called Climategate affair in December 2009. Subsequently, the CCTI declined to roughly the level of the 2002–2005 period and remained generally at this level.

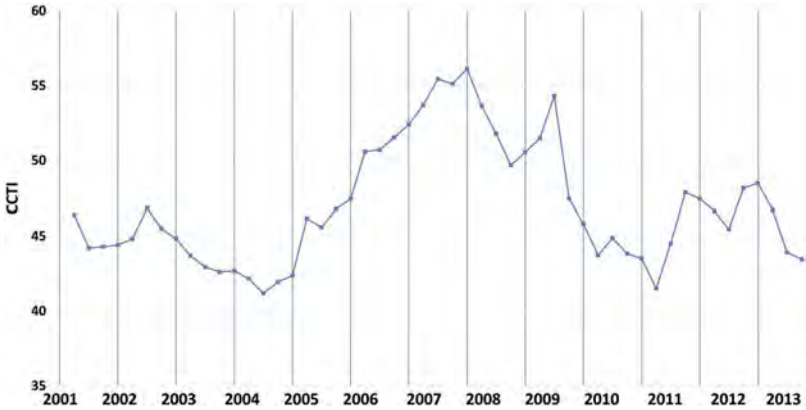

Figure 2. Climate change threat index, 2001–2013.

Independent variables

We include a broad set of theoretically derived explanatory variables. The measures we use are largely consistent with other studies that assess national-level shifts in public opinion (e.g., Brulle *et al.* 2012).

1. Availability of Scientific Information

- The number of articles about climate change in the refereed journal Science taken from the Reader's Guide to Periodicals (full text).
- Release of major scientific assessments of climate change. A dummy variable is coded as '1' in quarters where major climate assessments were released including IPCC reports (various years), America's Climate Choices (2010), Arctic Climate Impact Report (2005), and USGCRP 21 (2009).

2. Extreme Weather Events

To capture weather extremes, we used five measures of weather from the NOAA Climate Extremes Index (Gleason *et al.* 2008).

- Extremes in high temperature – percentage of United States with maximum temperatures much above normal.
- Extremes in low temperature – percentage of United States with low temperatures much below normal.
- Extremes in 1-day precipitation – twice the value of the percentage of the United States experiencing extreme (more than two inches) 1-day precipitation events.

- Drought levels – percent of United States in severe drought based on the PDSI.
- Landfalling hurricanes and major storms.

3. Political Discourse

(a) *Elite cues*. To capture elite cues from politicians, we include an index that includes three separate measures of Congressional action or speech on climate change. The index includes

- Senate and House roll call votes on climate change bills identified in the League of Conservation Voters National Environmental Scorecard.
- Number of Congressional hearings on climate. To gather counts of hearings, we use the Lexis-Nexis Congressional.
- Tone score of Congressional press release statements on climate change issued by members of Congress.[4]

(b) *Social movement efforts on climate change*. To capture efforts by movement groups, we utilized two measures centered on the number of press releases (see Bollen 1989):

- Number of press releases authored by environmental social movement groups that deal with climate change issues.
- Number of press releases authored by environmental counter-movement groups that deal with climate change issues.

Intermediary variables

Mass Media Coverage

We constructed a mass media index based on an additive index of three measures. Counts were based on hits taken from the Reader's Guide to Periodicals (full text) using the following keyword: 'climate change,' 'global warming,' 'greenhouse,' and 'atmospheric carbon dioxide.'

- Number of stories on climate change on the nightly news shows of the major broadcast TV networks (NBC, CBS, ABC, FOX, and CNN). Source: Vanderbilt Television Archive.
- Number of stories on climate change in *The New York Times*. Source: Lexis-Nexis Academic.
- Number of stories on climate change in major news magazines including *Newsweek, Time*, and *US News and World Report* as well as popular scientific magazine coverage of climate change in 15 major popular scientific magazines (e.g., *Scientific American, National Geographic, Discovery, Popular Science*). Source: Reader's Guide to Periodicals.

Control variables

We added two control variables that are seen to influence public concern about the environment:

- Unemployment rate (Source: Bureau of Labor Statistics).
- Gross domestic product (Source: Bureau of Economic Analysis).

Results and discussion

We begin our analyses by assessing the explanatory power (both direct and indirect) of a number of indicators of weather extremes on the CCTI. While the model specification is limited to extreme weather events, Figure 3 offers some important insights into climate change concern. Results from this

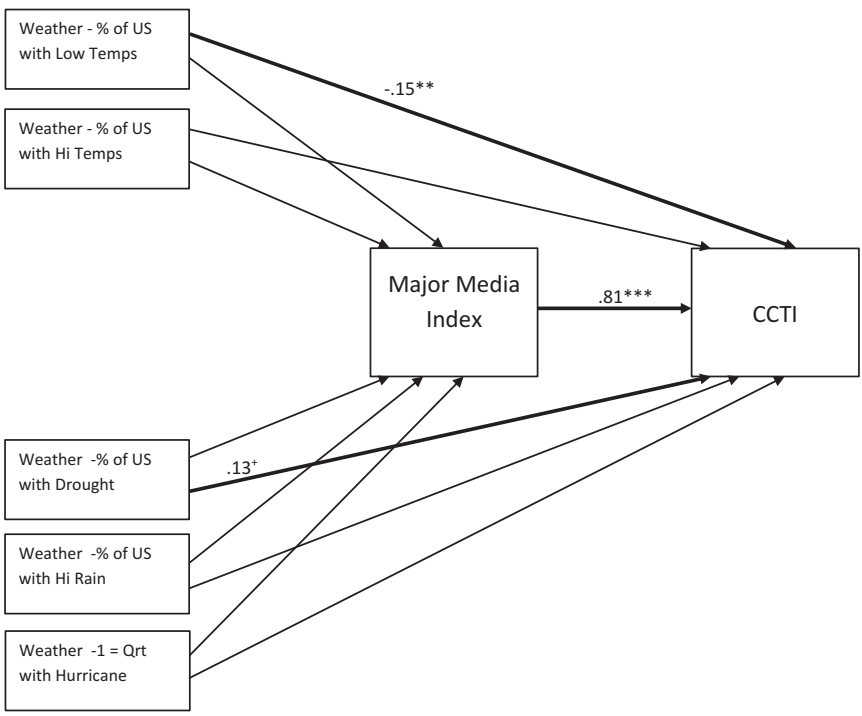

Figure 3. Model and estimated parameters for the influence of weather extremes on the climate change threat index (CCTI). $^{+}p \leq .1$; $^{*}p \leq .05$; $^{**}p \leq .01$; $^{***}p \leq .001$. *Only significant* ***standardized*** *coefficients are reported*. All displayed coefficients are significant using two-tailed tests (others are not significant). $N = 52$ (quarters). Overall model fit statistics: $\chi^2 = 53.27$; p-value $< .001$. CC refers to climate change. Major media index includes CC stories in NYT, WSJ, USATODAY, Network TV (ABC, CBS, NBC), major weekly magazines and the tone score of WSJ and NYT CC editorials.

figure show that three of the five indicators of weather extremes have no effect on the CCTI. It appears that having high temperatures and high rain (floods) does not have a significant influence on nationwide aggregate public opinion. Additionally, major hurricanes have a similar, nonsignificant relationship. Two indicators of weather extremes are, however, directly influencing public concern about climate change. We see from Figure 3 that when a greater share of the country is experiencing temperatures that are much *below normal*, there is a significant *decline* in overall public concern about climate change. The only weather extreme that significantly *increases* public concern about climate change is drought. Public concern about climate change is related to the immediate climate conditions in particular ways. Specifically, the public does not appear to link extreme cold with climate change but does so when there is little precipitation.

Figure 4 shows the results with all of our theoretically derived variables considered. The model simultaneously accounts for weather extremes, the availability of scientific information, elite cues, and movement efforts on climate change, as well as other structural conditions to see if such factors influence the CCTI either directly or through the media. We see here that only one of the two weather extreme indicators that were significant in Figure 3 remains so in this highly specified equation.[5] Thus, it appears that once we account for a number of other factors, only extreme drought conditions have a direct and statistically significant influence on nationwide aggregate measures of public concern about climate change. The SEM model clearly shows that weather events are either not related to climate change concerns or have relatively small effects when compared to other structural factors. This does not mean that individual level opinions are not impacted by weather events. Rather, the impacted populations are not large enough to move overall aggregate public opinion across the entire United States.

Our model does, however, provide strong support for claims that elite cues are highly influential in this process. In fact, Congressional dynamics are the most important driver of climate change public opinion operating through media coverage of climate change. This suggests that when Congress increases activity on climate change (i.e., more hearings, related votes, press releases on climate change), the media picks up these cues by increasing climate change coverage that then increases overall public concern. The SEM model also shows that an expansion of environmental movement activity on climate change is effective in so far as it increases media coverage on climate related issues.

It is noteworthy that countermovement efforts have no direct or indirect influence on public opinion in this area. This unexpected result is most likely due to the limitations of the measurements. Media coverage here only takes into account the quantity of coverage, not the content. Given that the

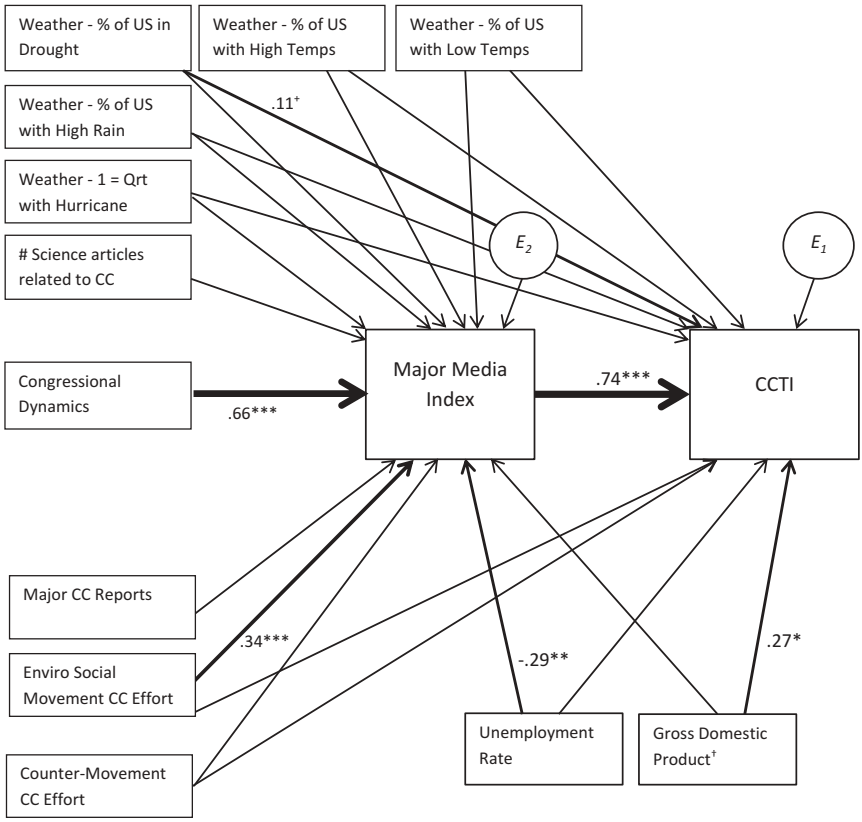

Figure 4. Full model and estimated parameters for the climate change threat index (CCTI). $^{+}p \leq .1$; $^{*}p \leq .05$; $^{**}p \leq .01$; $^{***}p \leq .001$. *Only significant standardized coefficients are reported*. All displayed coefficients are significant using two-tailed significance tests using robust standard errors (others are not significant). †Coefficients for GDP are multiplied by 100 to assist in interpretation. $N = 52$ (quarters). CC refers to climate change. Congressional dynamics index includes the count of pro-environmental votes (LCV), count of congressional hearings on CC, pro–anti CC 'tone' score of Congressional press releases. Major media index includes CC stories in NYT, WSJ, USATODAY, Network TV (ABC, CBS, NBC), major weekly magazines and the tone score of WSJ and NYT CC editorials.

media audience is highly segmented, it is certainly possible that specific media is impacted by countermovement activities. Additionally, the measure of public concern does not differentiate between ideological groupings. So, it could be that countermovement activities are able to drive down levels of concern within populations that obtain their information about climate change from outlets that are influenced by countermovement actions.

Economic factors have a significant impact on media coverage and public concern over climate change. When the economy improves (rising GDP), the public becomes more concerned about climate change and when the economy

contracts (rising unemployment), the media is significantly less likely to report on issues related to climate change. It appears that when the media is less concerned about poor economic conditions, it focuses on other issues, including climate change. Finally, two additional findings are worth mentioning. Despite expectations, we find no statistical support that dissemination of scientific information or the release of major climate change reports increases media coverage.[6]

Importantly, all the figures we present report only standardized regression coefficients that reach statistical significance. Standardized regression coefficients are advantageous because they allow for the direct comparison of the relative strength of each predictor in the model. These coefficients range from −1 to 1 and can both rank the importance of variables as well as gauge the magnitude of each effect (coefficients closer to 1 or negative 1 are strongest). That said, we can see from Figure 4 that the strongest positive predictor of media coverage of climate change is Congressional dynamics (.66) followed by social movement activity (.34). This indicates that the magnitude of the influence of Congressional dynamics on media coverage is nearly twice that of social movement activity on climate change. Furthermore, the strongest positive predictor of public concern about climate change is media coverage of the issue (.74) followed by GDP (.27) and lastly, the percentage of the country in drought conditions (.11). This is a rather powerful finding as it suggests the magnitude of the influence of media coverage (largely driven by political cues) is over six times that of extreme weather.

Our final model is presented in Figure 5. Here, we limit the model to just those factors that were significant in the previous model to ensure that our findings are robust to collinearity issues or degraded by the limited sample size. In this model, the same pattern emerges. Public opinion on climate change is *directly* influenced by media coverage, extreme drought conditions, and economic conditions but the most important driver of media remains elite cues from politicians and movement actors. It is noteworthy that model fit statistics (R^2) show that our fully specified model (Figure 4) accounts for 88% of the variation in media coverage of climate change and 75% of shifts in public concern about this issue. Our restricted models fairs nearly as well with 86% of media coverage explained and 72% of the CCTI accounted for. The SEM model, then, offers compelling evidence that our results indicating that public opinion related to climate change is largely shaped by the cues of elites that are expressed in the media and that these results are statistically robust.

Conclusions

We set out to test a number of hypotheses regarding the factors that drive levels of public concern over climate change. We found that weather events, in themselves, have little influence on the overall level of public concern

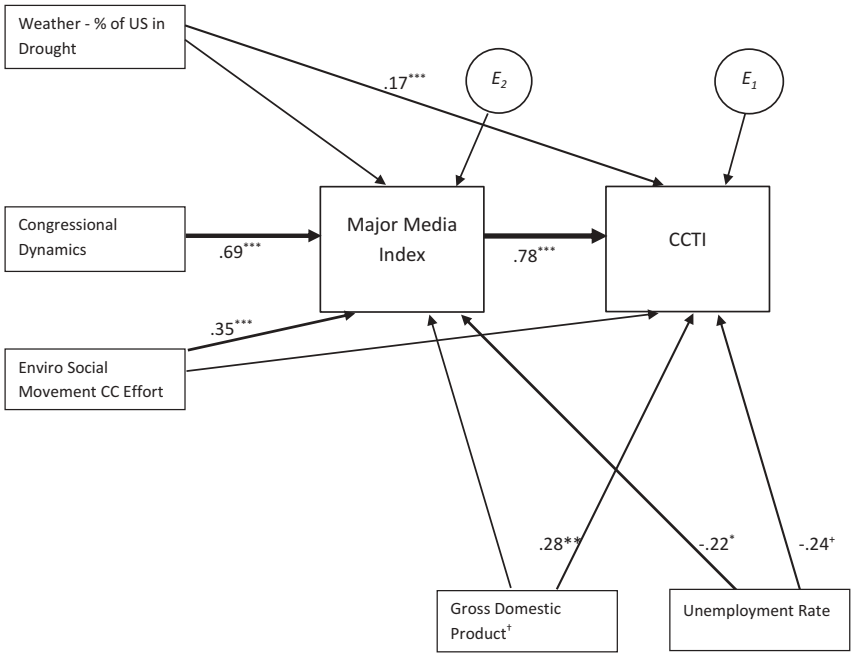

Figure 5. Restricted model and estimated parameters for the climate change threat index (CCTI). $^{+}p \leq .1$; $^{*}p \leq .05$; $^{**}p \leq .01$; $^{***}p \leq .001$. *Only significant standardized coefficients are reported.* All displayed coefficients are significant using two-tailed significance tests using robust standard errors (others are not significant). †Coefficients for GDP are multiplied by 100 to assist in interpretation. $N = 52$ (quarters). CC refers to climate change. Congressional dynamics index includes the count of pro-environmental votes (LCV), count of Congressional hearings on CC, pro–anti CC 'tone' score of Congressional press releases. Major media index includes CC stories in NYT, WSJ, USATODAY, Network TV (ABC, CBS, NBC), major weekly magazines and the tone score of WSJ and NYT CC editorials.

(only extreme drought conditions). This finding appears to run counter to the growing body of scholarship that suggests extreme weather can influence public opinion on climate change (e.g., Krosnick *et al.* 2006, Hamilton and Keim 2009, Borick and Rabe 2010, Spence *et al.* 2011, Egan and Mullin 2012, Hamilton *et al.* 2013, 2013, Howe *et al.* 2013, Brooks *et al.* 2014, Shao *et al.* 2014). It is likely that our results differ from previous scholarship because the bulk of those studies that identify a relationship between weather extremes and climate concern has focused on relatively small jurisdictions (e.g., states or counties), or on specific individuals. While it seems plausible that local weather events can influence opinion at that level, it is not inconsistent with a finding that few weather events were large enough to impact *national* opinion. The exception to that is extended drought conditions. It is likely that the long-running and extreme drought

conditions may be leading to small increases in overall public concern about climate change at the national level.

Our findings also show that the information-deficit model (Bord *et al.* 2000, Bauer *et al.* 2007) does not appear to explain shifts in national-level concern about climate change. The results presented here are consistent with Brulle *et al.* (2012) in showing that the promulgation of scientific information about climate change does not have a significant effect either directly on overall public concern or indirectly on levels of media coverage. Other, more directly political communications appear to be more important.

The major factors that affect levels of public concern about climate change can be grouped into three areas. First, and consistent with results from Brulle *et al.* (2012), media coverage of climate change directly affects the level of public concern: the greater the quantity of media coverage of climate change, the greater the level of public concern. This is in line with the Quantity of Coverage theory of media effects and existing individual level research on the impact of television coverage on climate change concern (Yin 1999, Capstick *et al.* 2015). The importance the media assigns to coverage of climate change translates into the importance the public attaches to this issue. Second, in a society with a limited amount of 'issue space,' unemployment, economic prosperity, and involvement in wars all compete with climate change for public concern.

The most important factor in influencing public opinion on climate change, however, is the elite partisan battle over the issue. The strongest effects on public concern are a function of increases in Congressional attention on climate change, which in turn influences media coverage, which then increases public concern about climate change. This finding greatly improves our understanding of factors influencing public concern about climate change.

Notes

1. While the sample size is significantly larger than those in previous analyses, it is still insufficient to reach robust conclusions regarding causality. However, given the limitations of continuous time-series data on public opinion regarding climate change, these limitations will not be overcome for several years if only a single nation is utilized in the analysis. What we hope to provide is a series of initial and tentative empirical conclusions that can contribute to a fuller effort to expand the scope of the analysis to develop a transnational analysis of the drivers of aggregate levels of climate change concern.
2. See Huxster *et al.* (2014) and Brulle *et al.* (2012) for an extended discussion of this approach and a list of the questions used in constructing this index.
3. Some scholars have advanced concerns about Stimson's algorithm (e.g., see McGann 2014) on the grounds that it is theoretically ad hoc because it does not

sufficiently link individual-level response behavior to the observed aggregate outcomes in the algorithm. While we recognize this ongoing debate, there is a sizable body of literature that has used the Stimson algorithm to produce aggregate measures of policy mood and many of these studies have provided ample evidence of its validity. Thus, we side with the bulk of the literature and employ the Stimson approach.

4. The tone scores are calculated based on a detailed coding scheme of all climate-related editorials and press releases published between 2001 and 2013. Each item was given a score of '0' if the statement was 'Anti-Climate Change Science or Climate Change Action' or a '1' if the statement reflected support for 'Pro-Climate Change Science or Climate Change Action'. Data were drawn from the Lexis-Nexis Congressional database. Climate-related press releases were identified using the following keywords: 'Climate Change,' Global Warming,' 'Greenhouse Effect,' and 'Carbon Dioxide.'
5. Note that the model is likely over-fitted given that we have only 52 cases. While simulations to assess the accuracy of SEM models (e.g., MacCallum *et al.* 1996; Wolf *et al.* 2013) suggest that our sample size is sufficient, results become biased as the number of IVs grows. These studies suggest that the primary consequence of having few cases and many IVs is inflated standard errors, which would make statistical significance less likely to be achieved. Given this, the results from our fully specified model should be considered with caution. Findings from our models with more limited specifications (Figures 3 and 5) serve as robustness tests.
6. We considered alternative proxies to capture the dissemination of scientific information in academic publications. Specifically, we assessed whether or not the number of climate-related articles in *Nature* could account for shifts in media coverage on this issue. Regardless of how we operationalized scientific information on climate change, it did not significantly influence media coverage on this issue.

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