

Party Cues in the News: Elite Opinion Leadership and Climate Skepticism

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Abstract

Supporters of the Republican Party have become much more skeptical of the science of climate change since the 1990s. We argue that this phenomenon can be explained by a model of top-down persuasion by party elites. We construct aggregate measures of climate skepticism from nearly 200 public opinion polls at the quarterly level from 2001 to 2014 and at the annual level from 1986 to 2014. We also build time series measures of possible contributors to climate skepticism using an automated media content analysis. Our analyses provide evidence that cues from party elites – especially from Democrats – are associated with aggregate dynamics in climate change skepticism including among supporters of the Republican Party. We then conduct a party cue survey experiment on a sample of 3,000 Americans through Amazon Mechanical Turk to provide more evidence of causality. Together, these results suggest we should see climate change skepticism through the lens of elite-led opinion formation.

American public opinion is highly polarized on climate change. Surveys show that an overwhelming majority of Democrats believe climate change is happening, while that same belief among Republicans is more muted, especially amongst the most conservative supporters of the GOP (Tesler 2017). This polarization mirrors where Democratic and Republican elites stand on the issue. But it was not always this way. Republicans once had beliefs in climate science comparable to Democrats. For example, in 1997 the gap between strong partisans on whether global warming was real was only 5 percentage points, with 73 percent of Democrats and 68 percent of Republicans believing that global warming was happening (Krosnick et al. 2000). Why exactly did an increasing number of Republicans come to reject the climate science consensus?

We argue that climate skepticism among Republicans may have been encouraged by polarizing party elite cues communicated through the news media. This top-down approach to attitude formation has a rich history in public opinion research (Berinsky 2009; Lenz 2012; Zaller 1992) and some scholars began to explore the role of elite cues in the context of climate change (Carmichael and Brulle 2017; Guber 2013; Tesler 2017). The role of party elites, however, has been underexplored in literature primarily focused on ideology-driven motivated cognition (Campbell and Kay 2014; Dixon et al. 2017; Kahan et al. 2011), organized climate skeptics and the journalistic practice of false balance (Boykoff and Boykoff 2007; Dunlap and McCright 2011; Dunlap and Jacques 2013), and economic costs and related media framing (Nisbett 2009; Scruggs and Benegal 2012). In this paper, we provide time series and experimental evidence that together suggest that party elites play a role in fostering skepticism of climate science, particularly among Republican Party supporters.

Party Elites and Climate Skepticism

Republican Party supporters are now much more skeptical of climate science than they were in the 1990s. Some scholars have highlighted ideology and values as the root cause of this phenomenon. These theories draw strongly from psychological research on motivated reasoning (Ditto and Lopez 1992; Kunda 1990). Citizens may be motivated to resist messages from experts or seek out information from contrarian sources in support for their values and identities (Kahan et al. 2011; Leiserowitz 2006; Lewandowsky and Oberauer 2016; Pasek 2017). And, in this case, the policy implications of climate change are not easily compatible with free market orthodoxy (Campbell and Kay 2014; Dixon et al. 2017; Oreskes and Conway 2010). In this view, we are very unlikely to change people's minds unless we can reconcile climate action with these value predispositions.

However, there are important limitations to this approach. First, most Americans do not harbour consistent ideological predispositions (Achen and Bartels 2016; Kinder and Kalmoe 2017). This fact becomes apparent in the climate change context when market-friendly ways to reduce carbon emissions, like carbon pricing, are much less popular among Republicans even with revenue recycling (Amdur et al. 2014). Most people who label themselves conservatives do not take consistent conservative positions on fiscal issues (Barber and Pope 2017; Drutman 2017). More importantly for our purposes here, explanations rooted in motivated reasoning do not easily account for dynamics – conservatives and Republicans once had very similar views on climate change as liberals and Democrats (Krosnick et al. 2000). And it is the dynamics that interest us most here.

We believe considerable light is shed on this question by a long line of work in political science that has shown the importance of top-down persuasion by party elites, which has been underemphasized in science communication research. This occurs because many people use cues from parties as cognitive short cuts to make decisions in a low information context (Berinsky 2009; Cohen 2003; Conover and Feldman 1989; Kam 2005; Lenz 2012; Nicholson 2012; Popkin 1991) or form opinions in line with their strong affect-oriented attachments to parties (Iyengar et al. 2012; Lodge and Taber 2013). As a result, party elites can have considerable persuasive power (Cohen 2003; Kam 2005). The media play an important role in this process, as they communicate these signals to the broader public when indexing elite debate (Althaus et al. 1996; Bennett 1990; Dalton et al. 1998).

There are grounds to expect that party elite cues may have played an important role in fostering climate skepticism. Most Americans get their information on climate change primarily from the news media (Tesler 2017), which has increasingly carried party cues to the public as the issue rose in salience (Merkley and Stecula 2018), and, unlike in other countries, signals the existence of a sharp political divide to the public (McCright and Dunlap 2011). Elite cues certainly had the *opportunity* to shape American attitudes on climate change, but that is far from evidence they may have been responsible for dynamics in climate skepticism.

Observational evidence has been consistent with the predictions of elite cueing theory. We should expect the largest divergence between partisan identifiers among those who are most attentive to elite signals in the media (Zaller 1992). This is indeed the case. The sharpest divide exists among those who are high in education, those who consume the most news, and those who are most attentive to the issue (Guber 2013; Tesler 2017). Importantly, this theory also passes a placebo test – this finding does not hold in other countries where party elites are not as divided on climate action (Tesler 2017). Second, research has found that concern about climate change is correlated with legislative activity

like committee hearings – behavior that is to some degree covered by the media (Carmichael and Brulle 2017). Finally, there is some experimental evidence that softening Republican elite positions on climate change would change Republican attitudes towards climate science (Tesler 2017).

One other observable implication of party cueing theory is that we should expect there to be some association between the prevalence of cues from parties in the news media – where most Americans learn about climate change – and climate skepticism. Most of the party cue literature focuses on *in-group cues*, where partisans are responsive to cues from their own party’s elites. In this case, we might expect aggregate levels of skepticism to be strongly correlated with Republican elite cues hostile towards climate science. However, *out-group cues* also matter (Nicholson 2012), likely as a result of rising levels of affective polarization in the American public (Iyengar et al. 2012). Signals from Democratic elites on climate change may backfire on supporters of the Republican Party.

One complication in interpreting over time correlations on this question is the threat of reverse causality. A sizable literature in opinion formation tells us that elites are often an important influence on public attitudes (Lenz 2012; Zaller 1992), but policymakers are often responsive to public opinion for the purposes of securing re-election (Erikson et al. 2002). As a result, we want to see that in-group and out-group party cues lead, rather than follow aggregate levels of climate skepticism.

H1A (In-group): The prevalence of Republican Party elite cues in the news lead aggregate levels of skepticism towards climate science.

H1B (Out-group): The prevalence of Democratic Party elite cues in the news lead aggregate levels of skepticism towards climate science.

The hypotheses above are tested with vector autoregression (VAR). More will be said on this below, but one limitation of this approach is that it does not speak to contemporaneous relationships between variables. For more evidence of a causal process, we want to also show that there is positive, *contemporaneous* association between these variables, holding constant other factors we might think are important.

One possible source of confounds are dynamics found in political discourse. More specifically, frames in discourse may influence climate skepticism, while also being correlated with the prevalence of party elite cues. This is because party elites use such frames when justifying the stances they take in

news coverage of climate change. Frames that emphasize the economic costs of climate mitigation or scientific uncertainty might be of particular importance in explaining climate skepticism.

A wide range of scholarship has looked to economic cost and scientific uncertainty as two dimensions of framing that has undermined popular support for climate change. We know that poor economic conditions (Brulle et al. 2012; Carmichael and Brulle 2017; Elliott et al. 1997; Scruggs and Benegal 2012), energy prices (Scruggs and Benegal 2012), and the cost of reforms reduce support for policy action (Ansolabehere and Konisky 2014; Bechtel and Scheve 2013). In light of this, opponents of climate change action use frames related to economic cost, which is carried to the mass public by the media (Nisbet 2009). Over the course of a policy debate where costs and benefits are debated these frames appear with some regularity (Stecula and Merkley 2019), and experimental evidence has shown that these frames can move public opinion (Davis 1995; Vries et al. 2016).

Other analysts have highlighted a campaign orchestrated by industry and conservative movement groups to highlight supposed uncertainties in the fundamental tenants of the consensus of the Intergovernmental Panel on Climate Change (IPCC) – that climate change is happening, man-made, and a serious threat (Dunlap and Jacques 2013; Farrell 2016a, 2016b; Jacques et al. 2008). They engaged in this framing in order to reify the status quo (Feyinga et al. 2010). Journalists, for their part, unwittingly elevated these arguments to provide balanced coverage (Boykoff and Boykoff 2007; Dunlap and McCright 2011). Content analyses have shown that uncertainty framing has been prevalent in the past (Boykoff 2007; Boykoff and Boykoff 2007; Painter 2012; Painter and Ashe 2012), and there is some experimental research that the citation of contrarian experts does indeed confuse the public on the state of science (Corbett and Durfee 2004; Friedman et al. 1999; Koehler 2016).

These frames may influence public attitudes towards climate change. These are also frames that are likely to be used by Republican Party elites in the course of a political debate. To the extent that dynamics in these frames are correlated with party elite cues, they may serve as confounds, which leads to two further hypotheses:

H2A (In-group): There is a positive, contemporaneous correlation between the prevalence of Republican Party elite cues and climate skepticism, holding other factors constant.

H2B (Out-group): There is a positive, contemporaneous correlation between the prevalence of Democratic Party elite cues and climate skepticism, holding other factors constant.

Showing evidence of a correlation between party elite cues and aggregate climate skepticism in which the former has temporal precedence and where the relationship is robust to controls would provide some evidence that party cues influence levels of climate skepticism, but ultimately such a design is not causal. A large experimental literature has shown party cues can influence attitudes on a number of questions related to public policy, but stronger evidence of this in the context of climate change attitudes would be helpful to strengthen the case made by our observational analyses.

H3A (In-group): Skepticism of climate science will be higher among Republicans when respondents are exposed to a cue signaling the opposition of the Republican Party to climate science and mitigation.

H3B (Out-group): Skepticism of climate science will be higher among Republicans when respondents are exposed to a cue signaling the support of the Democratic Party to climate science and mitigation.

Aggregate Time Series Data and Methods

We begin by outlining the method and results for our aggregate time series analyses before moving on to the design and results of our experiment. We follow the lead of Stimson (1999) in measuring aggregate levels of climate change skepticism. He combined results from a wide variety of survey questions to capture the general left-right mood of the American public over the postwar era. This approach has been replicated with some climate change opinion data (Carmichael and Brulle 2017; Carmichael et al. 2012). We use a similar approach here by combining 172 different poll questions since the late 1980s from the Roper Center archive at Cornell University, which is a repository of a wide selection of polls addressing climate change attitudes.

The questions we use for our measure include those that asked respondents whether or not climate change is happening, whether or not climate change is a serious problem, whether or not they

are worried about global warming, and whether or not climate change is caused by humans.¹ After ensuring all of the questions were coded in the same direction, we used them to extract a latent measure of public skepticism of climate change. We were able to construct an annual measure beginning in 1986 and a quarterly measure starting in 2001 with available polling data. Our aggregate climate skepticism measures are presented in the left and center panels of Figure 1.

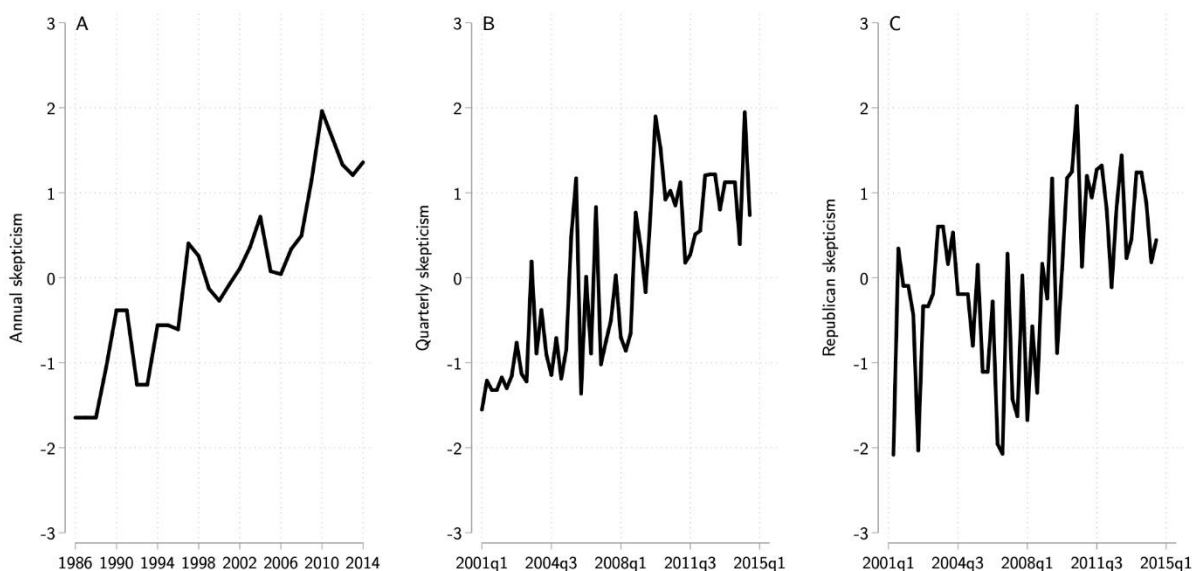


Figure 1. Climate Change Skepticism. A) Annual, 1986-2014, B) Quarterly, 2001-2014, C) Republicans, Quarterly, 2001-2014. Note: all series displayed without WCalc smoothing.

The aggregate measures of climate skepticism used here, however, do not tell us what is happening with Republican identifiers specifically. Carmichael and Brulle (2017) constructed a quarterly measure for Republicans starting in 2001 using the same method. Their *Partisan Climate Change Threat Index* (PCCTI) uses a slightly different subset of climate change polling questions – focused exclusively on perceptions of the seriousness of the threat posed by climate change. The series for Republican identifiers is presented in panel C of Figure 1 reverse-coded so that higher values indicate more skepticism of climate change. Our quarterly variant of aggregate climate skepticism is

¹ The data presented in the paper is based on the broadest set of questions that we found, coupled with the questions shared by Carmichael, Brulle and Huxster. This measure excludes outliers, though they do not substantively change the results. More information on the mood measure can be found in section A of the supplementary information.

highly correlated with the reverse-coded Republican PCCTI (0.48). We standardize our public opinion measures for ease of interpretability.

The dynamics of aggregate opinion on climate science are likely explained in part by changes in the media information environment. As a result, our primary variables of interest are constructed from a media content analysis. We downloaded climate change coverage of the *New York Times* and the *Washington Post* from *LexisNexis*. We chose these sources because they are traditionally seen as agenda-setting outlets throughout our period of study (McCombs 2005).² Articles and transcripts were selected if they mentioned climate change or global warming in the body of the text or the subject tag. We then ensured the articles were relevant and primarily focused on climate change.³

Our definition of a party cue in this context is an *explicit or implicit stance on climate change science or related policy attributed to elites of either the Democratic or Republican Party*. We measure these cues using the automated content analysis software *Lexicoder* in conjunction with a dictionary of key terms, such as party names, office titles and party leaders. These leadership positions include presidents, presidential nominees, vice presidents, Speakers of the House, and Senate and House majority and minority leaders. Our dictionaries can be found in section B of the supplementary information. We classify articles for whether or not they have reference to the Democratic or Republican Party and their respective elites. Of course, not all articles with party references contain cues signaling elite positions on climate change, but the overwhelming majority of them do. We manually coded a random sample of 700 articles that had a reference to either party in the text to validate our automated measure. Approximately 80% of these articles contained what could be considered a cue on climate change by our definition.

We constructed a time series measure of the *share* of articles in a given period that contain cues from Democratic and Republican elites, respectively. We use shares because volume measures are more likely to be correlated with other factors that are also associated with the overall salience of

² Although, this may have changed recently with the growth of partisan online media (see Vargo and Guo 2017).

³ We accomplished that by hand coding over 1000 articles for relevance and then using ensemble-based supervised machine learning with the *RTextTools* package to purge our sample of irrelevant articles.

climate change. However, our results are robust to using measures of the volume of articles with party cues as shown in Table D1 of the supplementary materials.

One limitation of using these measures is that they do not account for the message being conveyed by party elites. For a related project, we manually coded a random sample of 3000 news articles and transcripts on climate change that an identical automated analysis indicated featured either Democratic and Republican cues. We coded articles for whether they contained a consistent message from a party either in favour or opposed to the climate consensus, or if the messages in the article were mixed in their orientation.⁴ The overwhelming majority (97%) of articles featuring messages from Democratic elites contained messages that were supportive of the climate consensus, even as far back as the 1980s. In contrast, Republican elites oscillated between periods of strident opposition to the climate consensus, such as during the Kyoto debate, and conciliatory messages during the later stages of the Bush administration. Notably, our coding of the share of Republican messages hostile to climate science and mitigation is highly correlated (0.72) with the League of Conservation Voters congressional roll call score on the environment for Republicans in the House and Senate, suggesting it is a valid indicator of the stance taken by Republican elites on climate change.

Consequently, we multiply the proportion of climate news stories with Republican cues by the proportion of Republican messages uniformly hostile to climate science or mitigation. This gives us an estimate of the share of climate news stories with Republican cues with this specific message. We show the comparison between the share of news stories with Republican cues, our hand coding, and our composite measure in Figure C1 of the supplementary materials. We use this composite measure in the analyses that follow.

Our quarterly measures for Democratic and Republican cues are displayed in panel A of Figure 2. The panel shows that Democratic cues have had a sustained increase since 2008, while Republican cues with messages hostile to climate science and mitigation have been on the decline since 2001. An annual version of this graph starting in 1986 can be found in panel A of Figure C2 of the supplementary materials.

⁴ We trained an undergraduate coder to replicate our coding on a sample of 300 articles with Democratic or Republican cues, respectively. There was high agreement between our coding and that of our undergraduate research assistant with Krippendorff's alpha scores of 0.98 for Democratic messages and 0.83 for Republican messages.

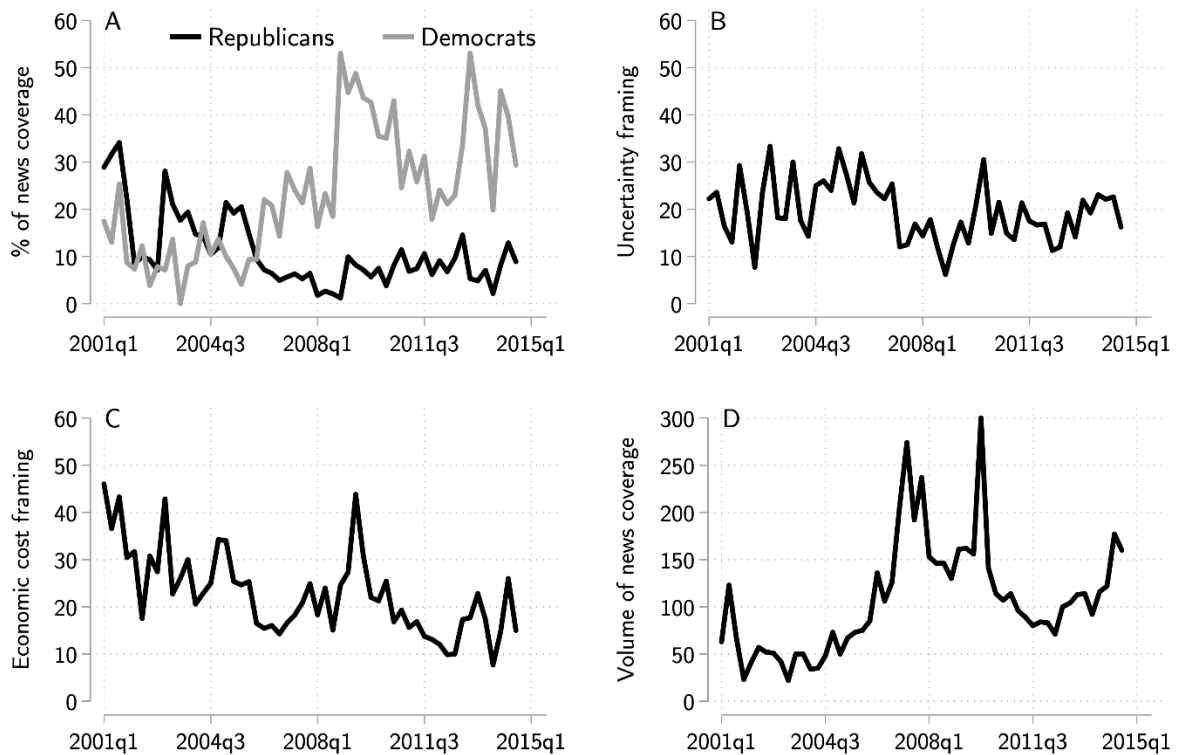


Figure 2. Potential Polarizers in the News, Quarterly Data 2001-2014. A) Democratic, and Republican cues in news coverage; B) Uncertainty framing; C) Economic cost framing; D) Salience of coverage.

Models

The first set of hypotheses address the direction of the association between party cues and aggregate climate skepticism. We can shed some light on this by estimating a reduced form vector autoregression (VAR) where our endogenous variables are regressed on their past values and the past values of the other endogenous variables in our system. The downside of this approach is that it does not tell us anything about the contemporaneous relationships between the variables. We cannot use the results to infer causality. We can, however, learn whether one variable “granger causes” another – that is, do past values of an variable facilitate the prediction of current values of another variable above and beyond the previous values of other variables in the system.

We estimate a series of VAR equations to disentangle the relationship between aggregate climate skepticism and party elite cues.⁵ We control for exogenous changes in the climate, comprised of a standardized index by the NOAA of the share of days below the average temperature or in drought conditions. We also hold constant exogenous dynamics in economic conditions, proxied with unemployment rates and crude oil prices taken from the Federal Reserve's FRED database. Finally, we control for seasonality with dummies representing the quarter of the year. We do not control for a linear trend because we do not think it is theoretically defensible. Ultimately, we are interested in accounting for any trends in public attitudes towards climate change. Here we display the results of granger causality tests. We expect both Republican and Democratic elite cues to granger cause aggregate climate skepticism, but not the reverse (H1A & H1B).

To test our second set of hypotheses, we estimate lagged dependent variable models quarterly from 2001 to 2014 and annually from 1986 to 2014 that regress aggregate climate skepticism on its lag, party cues, and a set of controls. We have theoretical reason to expect memory in our dependent variable – climate skepticism at $t-1$ is likely to partially cause its value at t because there tends to be stickiness in public opinion – so omitting the lag could lead to biased estimates. More formally, the model is represented in equation 1. β_1 and β_2 should be positive and significant to provide support for H2A and H2B, respectively.

$$\text{climate skepticism}_t = \alpha + \delta \text{climate skepticism}_{t-1} + \beta_1 \text{democratic cues}_t + \beta_2 \text{gop cues}_t + \beta_{3-11} X + \varepsilon \quad (1)$$

X in the above equation represents a series of media and non-media controls. First, we have some expectation that frames related to uncertainty and economic cost may be both associated with the prevalence of party elite cues and climate attitudes. Emphasis frames can be less adequately

⁵ VAR estimates are somewhat sensitive to the chosen lag lengths, particularly with T in the small to intermediate range. Theoretically, we do not expect our variables to cause other variables past a lag length of four quarters, or a year. There are a number of different methods to choose the appropriate lag length. In cases of disagreement between the tests on the appropriate lag length, the higher lag length was chosen. All characteristic roots lie inside the unit circle, meeting the stability condition for a stationary VAR system.

captured with simple dictionaries. As a result we identified stories with economic cost and uncertainty frames by using supervised machine learning, which is increasingly used to study news content and political discourse more broadly (Grimmer and Stewart, 2013, Lacy et al., 2015).

We manually coded a random sample of 2,179 newspaper articles stratified across three periods (1980-1996, 1997-2005, and 2006-2014) to minimize any fluctuation in the performance of the algorithm as climate change rose in salience. Articles and transcripts were coded as “1” if they have discussion of perceived costs of climate change mitigation, such as higher energy prices, a weaker economy, fewer jobs, declining competitiveness against developing countries, and costs of regulatory compliance. These articles contained *economic cost* frames. On a separate dimension they were coded “1” if they had any discussion questioning the major elements of the IPCC consensus – that climate change is happening, predominantly man-made, and a serious threat.⁶ These articles contained *uncertainty* frames.

We trained a pair of Support Vector Machine (SVM) algorithms on our manually coded articles.⁷ SVM is a supervised machine learning technique that plots data points on an n-dimensional space to find a hyperplane that best differentiates different classes of objects. We randomly divided our manually coded set into a training (80%) and testing set (20%) for each coding task to validate our automated classification. We found reasonably close agreement between our classifier and our manual coding. Importantly the prevalence of false positives and false negatives are similar, meaning our

⁶ One researcher completed the hand coding of the full set. The second researcher randomly selected 10% of this articles (200 articles) to validate the coding. Our Krippendorff’s Alpha score is 0.88 for uncertainty frames (96% agreement), and 0.87 for economic cost frames (95% agreement). Our manual coding input is highly reliable.

⁷ We randomly removed articles from the manually coded set classified as “0” for each coding task in order to ensure those classified as “1” represented at least a third of the manually coded set. We found algorithm performance could be optimized by providing more balance between classes in the training set. This resulted in a combined hand coded set of 1,878 articles for economic cost frames, and 1,179 articles for uncertainty frames.

estimates of the prevalence of these frames are likely unbiased over a large number of observations in each period.⁸

Panel B of Figure 1 displays the prevalence of uncertainty frames at the quarterly level since 2001. They have declined from around 20 to 25% before 2007 to 15% afterward. The annual variant of this graph in panel B of Figure C2 shows more clearly that uncertainty frames have been on the decline since a peak of around 45% in 1997. Panel C illustrates the dynamics of economic cost frames. They too have been on the decline since 2001. The annual variant in panel C of Figure C2 shows that they tend to increase in times of policy debate, like in 1992, 1997, and 2001.

As expected, the prevalence of Republican cues are correlated with economic cost frames quarterly (0.64) and annually (0.55), but interestingly not as strongly with the prevalence of uncertainty frames (0.34 & -0.07). Nevertheless, controlling for the dynamics in these frames will give us more confidence that we are seeing evidence of a causal association between party elite cues and climate skepticism. Second, we control for salience with the combined number of stories in the *New York Times* and the *Washington Post* on climate change. The volume of articles is plotted in panel D of Figure 2. Salience steadily increased going into 2007, and spiked again in 2009 and 2010. There appears to have been a sustained increase in the equilibrium level of climate change salience. The annual variant of this plot can be found in panel D of Figure C2 in the supplementary materials. The prevalence of Democratic cues is highly correlated with climate change salience quarterly (0.57) and annually (0.57), however, this is not true with Republican cues (-0.45 & 0.11). Finally, we preserve our controls for climate and economic conditions, and seasonality from the VAR models.

Aggregate Time Series Results

Displayed in Table 1 are the results of granger causality tests. The top panel shows our tests using quarterly aggregate climate skepticism, while the bottom panel uses our measure of climate skepticism for Republican identifiers. There is only weak and inconsistent evidence of an in-group cue-taking process (H1A). Republican cues do not granger cause overall aggregate levels of climate skepticism ($p \sim 0.94$), but they do weakly granger cause skepticism for Republicans specifically

⁸ Our cost frame classifier was 80% accurate with average recall and precision scores of 0.76 and 0.80, respectively. Our uncertainty frame classifier was 77% accurate with average recall and precision scores of 0.70 and 0.68, respectively.

($p \sim 0.09$). Climate skepticism does not granger cause Republican cues in either case ($p \sim 0.82$ & $p \sim 0.99$).

There is stronger evidence that Democratic cues lead climate skepticism. These signals in the news media granger cause aggregate climate skepticism ($p \sim 0.01$) and climate skepticism specifically among Republican identifiers ($p \sim 0.03$), while climate skepticism does not granger cause these cues ($p \sim 0.32$ & $p \sim 0.86$). The VAR analyses provide some evidence of a cue-taking on climate change, with a comparatively stronger sign of out-group cue-taking among Republicans (H2B).

Table 1. Granger Causality Tests

# of Lags	Granger Causality Tests	chi2	p-value
2	Democratic Cues \rightarrow Climate Skepticism	6.96	0.01
	Climate Skepticism \rightarrow Democratic Cues	1.01	0.32
1	GOP Cues \rightarrow Climate Skepticism	0.00	0.94
	Climate Skepticism \rightarrow GOP Cues	0.05	0.82
2	Democratic Cues \rightarrow GOP Climate Skepticism	7.35	0.03
	GOP Climate Skepticism \rightarrow Democratic Cues	0.29	0.86
1	GOP Cues \rightarrow GOP Climate Skepticism	2.94	0.09
	GOP Climate Skepticism \rightarrow GOP Cues	0.00	0.99

One limitation of the previous analyses is that they do not provide evidence of contemporaneous relationships. We might also want to tease out whether it is the dynamics in party cues that are affecting opinion or other elements of media discourse doing the work that are likely correlated with such cues. Table 2 provides our results for our contemporaneous models. Again, there is stronger evidence of an out-group cue-taking (H2A). Model 1 shows that A 10 percentage point increase in the share of Democratic cues in climate coverage is associated with a 0.2 standard deviation increase in climate skepticism ($p \sim 0.07$). Republican cues are non-significant. Aside from Democratic cues, unemployment also appears to be strongly correlated with aggregate climate skepticism ($p < 0.01$).

Our quarterly model of aggregate climate skepticism is constrained to the period of 2001-2014 because of polling availability. The same result holds for our annual version of the series starting in 1986 (Model 2). A 10 percentage point increase in the prevalence of Democratic cues is associated with a 0.2 standard deviation increase in aggregate climate skepticism ($p \sim 0.04$). Republican cues are not significantly related to aggregate climate skepticism ($p \sim 0.62$).

Table 2. Predictors of Aggregate Climate Change Skepticism

	Aggregate Climate Skepticism		GOP Climate Skepticism
	Quarterly	Annually	Quarterly
	1	2	3
Democratic Cues	0.02*	0.02**	0.03***
	(0.01)	(0.01)	(0.01)
Republican Cues	0.02	0.01	0.04**
	(0.01)	(0.02)	(0.02)
Uncertainty Frames	-0.00	0.02	0.01
	(0.01)	(0.01)	(0.02)
Cost Frames	-0.02	-0.00	-0.02
	(0.01)	(0.02)	(0.02)
Media Salience	0.00	0.00	-0.00**
	(0.00)	(0.00)	(0.01)
Climate Index	-0.11	0.21	-0.06
	(0.08)	(0.12)	(0.10)
Oil Prices	0.00	-0.00	0.00
	(0.01)	(0.01)	(0.00)
Unemployment Rate	0.23***	0.08	0.31***
	(0.07)	(0.06)	(0.08)
DV _{t-1}	0.06	0.65***	-0.11
	(0.17)	(0.14)	(0.14)
Constant	-2.43***	-1.31	-2.56***
N	55	28	54
R ²	0.72	0.89	0.60

Robust standard errors in parentheses, * p<0.1 ** p<0.05 *** p<0.01

Model 3 provides some evidence of both in-group (H2A) and out-group cue-taking (H2B) using our measure of Republican skepticism towards climate change provided by the PCCTI. A 10 percentage point increase in Democratic cues is associated with an increase in 0.3 standard deviation increase in Republican climate skepticism ($p < 0.01$), while a 10 percentage point increase in Republican cues opposed to the climate change science or mitigation is associated with a 0.4 standard deviation increase in Republican climate skepticism ($p \sim 0.02$). After controlling for party cue prevalence, uncertainty and economic cost framing is not associated with Republican climate skepticism. Republicans also appear responsive to the unemployment rate. A one point increase in the unemployment rate is associated with a 0.3 standard deviation increase in climate skepticism ($p < 0.001$). Interestingly, Republicans become less skeptical of climate change when salience increases when controlling for the prevalence of party cues. An increase in 100 news articles per quarter about

climate change is associated with a decrease in 0.4 standard deviations in Republican climate skepticism ($p \sim 0.03$).

The previous results provide consistent support for an out-group cue-taking effect in climate change attitudes (H2B). Democratic cues appear to be a key predictor of aggregate levels of climate change skepticism, as well as skepticism among Republicans specifically. Importantly, these cues lead, rather than follow, opinion (H1B). There is comparatively mixed evidence for in-group cuing (H1A & H2A).

Experimental Design

The previous section provides some empirical evidence that party elite cues lead aggregate levels of climate skepticism and are strongly associated even after controlling for other elements of political discourse that might matter in shaping those dynamics. However, aggregate time series analyses only provide suggestive evidence of causality. There may be some other factors we have not measured over time acting as confounders.

For stronger evidence of a causal link between party cues and polarization, we conducted a survey experiment on a sample of almost 3,000 American respondents from Amazon Mechanical Turk (MTurk) in 2019. This sample is comparable to the American public in gender, race, partisanship, and ideology. But, it skews younger, wealthier, and more educated. A comparison between our MTurk sample and the 2016 General Social Survey is shown in Table E1 in the supplementary information. This sample is comprised of people who are more likely to pay attention to climate change and to have well-formed opinions on the issue. Any treatment effects found in this sample are likely to be, if anything, a conservative estimate of the effect of elite cues on the American public.

All respondents received a short statement outlining the scientific consensus on climate change. We randomly assigned respondents into one of two conditions to receive a cue about climate science and mitigation policy from Democratic elites. In the control condition respondents received no such cue. We also randomly assigned respondents into three conditions to receive cues from Republican elites. One treatment condition signaled Republican opposition to climate science and mitigation policy, while another condition provided information that Republican elites were increasingly likely to support the scientific consensus and climate mitigation policy. Respondents in the control condition received no cue from Republican elites.

Table 3. Party Cue Experimental Conditions

N= 2970	No Democratic cue	Democratic cue
No GOP cue	N=472 (Control)	N=505 (Democratic cue)
Opposing GOP cue	N=495 (Opposing GOP cue)	N=493 (Polarized cues)
Supporting GOP cue	N=534 (Supporting GOP cue)	N=471 (Consensus cues)

The experimental conditions are displayed in Table 3 and the text of the treatments can be found in the supplementary information. From these randomizations we can extract six distinct experimental conditions. The control condition does not contain a party cue of any sort. The *Democratic cue* condition contains only a cue from Democratic elites. The *opposing Republican cue* condition contains only a cue from Republican elites expressing skepticism in climate science and opposition to climate mitigation, while the *polarized cues* condition contains both this cue and the one from Democratic elites. The *supporting Republican cue* condition only contains a cue signaling increasing Republican acceptance of climate science and mitigation policy, while the *consensus cues* condition contains both this cue and a cue from Democratic elites.

The experimental protocol was as follows. Respondents first completed a short pre-treatment survey featuring questions related to their demographics and socio-economic status. They also indicated their partisanship and were given a pair of screener questions.⁹ Respondents were then exposed to the party cue corresponding to their treatment condition. They finally answered a question related to our dependent variable of interest – climate skepticism – by indicating their level of agreement with the following statement (Strongly agree to strongly disagree, 7-point):

The Earth is getting warmer mostly because of human activity, such as burning fossil fuels

Fully 80% of respondents agree with the scientific consensus at some level, while only 13% disagreed to some degree. We re-scale this variable from 0 to 1 for the following analysis, where 1 indicates respondents who are the most skeptical of climate science. All descriptions of the variables can be found in Table E2 in the supplementary information.

⁹ 85% of respondents passed both screener questions. MTurk has increasingly – as of 2019 – faced challenges to data quality resulting from bots and those using VPNs to mask their international locations. We used a screening protocol to address this issue (see Winter et al., 2019). We also drop 130 respondents (4%) who failed both screener questions.

Model

We estimate a simple model using OLS regression where we interact each of our treatment conditions with a measure of respondent partisanship on a 7-point scale ranging from strongly Democratic to strongly Republican. Partisanship, however, cannot be randomly assigned. Our treatment may have heterogeneous effects across other variables that are correlated with partisanship. One likely possibility is that the effect of our cue treatment may be moderated by the trust people have towards scientists – independent of partisan considerations – because each of our treatments involve parties either supporting or rejecting the scientific consensus illustrated in the control condition. The effectiveness of our treatment also likely varies across levels of political interest. We control for each of these variables and their interactions with our treatment conditions in our model with X representing our controls shown below in equation 2:

$$\begin{aligned} \text{climate skepticism} = & \alpha + \beta_1 \text{Democratic cue} + \beta_2 \text{opposing Republican cue} + \beta_3 \text{polarized cues} + \\ & \beta_4 \text{supporting Republican cue} + \beta_5 \text{consensus cues} + \beta_6 \text{PID} + \beta_7 \text{PID} * \text{Democratic cue} + \\ & \beta_8 \text{PID} * \text{opposing Republican cue} + \beta_9 \text{PID} * \text{polarized cues} + \beta_{10} \text{PID} * \text{supporting Republican cue} \\ & + \beta_{11} \text{PID} * \text{consensus cues} + X + X * \beta \text{Democratic cue} + X * \beta \text{opposing Republican cue} + \\ & + X * \beta \text{polarized cues} + X * \beta \text{supporting Republican cue} + X * \beta \text{consensus cues} + \epsilon \end{aligned} \quad (2)$$

We expect positive, significant coefficients on β_7 through β_9 to provide experimental support for our time series analyses.

Experimental Results

The estimated marginal effects from the model based on equation 2 are displayed below in Figure 3. The full estimation results can be found in Table E3 of the supplementary information.¹⁰

¹⁰ Table E3 also presents estimates of models without controls, and with the controls used here along with ideology. Ideology and partisanship are highly correlated in this sample (0.78), but nevertheless treatment effects for the Democratic and polarized cue conditions remain robust to including it as a control. Marginal effects are found in Figures E1 and E2 in the supplementary information.

The results strongly support the findings of the aggregate time series analyses. Panel A shows the estimated effect of a Democratic Party cue on climate skepticism. The interaction term is positive and significant ($p \sim 0.05$). There is no significant effect on climate skepticism for those who are strongly Democratic, but among strong Republicans there is estimated to be an increase in climate skepticism of 0.06 points on the 0 to 1 climate skepticism scale – or about 0.2 standard deviations on that measure ($p \sim 0.03$). The interaction for the opposing Republican cue treatment is also significant (Panel B; $p \sim 0.02$). Again, there is no estimated effect of this treatment on strong Democrats, but among strong Republicans there is expected to be a similar 0.06 point increase on the climate skepticism index in response to the cue ($p \sim 0.02$). There is evidence here of both in-group and out-group cue-taking, primarily for Republican Party supporters.

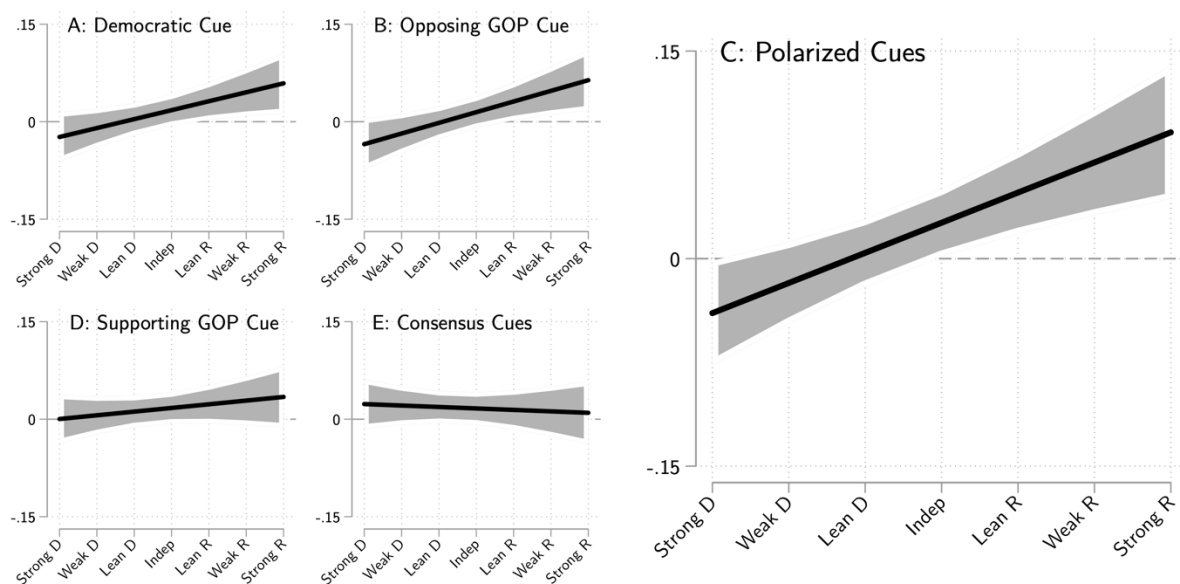


Figure 3. Estimated Effect of Party Cue Treatments on Climate Change Skepticism. (A) Democratic cue treatment; (B) Opposition Republican cue treatment; (C) Supportive Republican cue treatment; (D) Consensus cue treatments; (E) Polarized cue treatment. Note: 90% confidence intervals.

Unsurprisingly, the treatment condition that contained both Democratic and opposing Republican cues also has a significant interaction (Panel C; $p \sim 0.003$). There is expected to be a modest treatment effect among strong Democrats in the expected direction of 0.04 points, but it is only marginally significant ($p \sim 0.09$). Strong Republicans, however, are expected to increase their skepticism

towards climate change by 0.09 points or 0.3 standard deviations on this measure ($p \sim 0.002$). These effects are stronger than those of the Democratic cue and opposing Republican cue conditions, but the interaction term is not significantly different from either. In contrast, neither the supporting Republican cue nor the consensus cue treatment conditions exerted a polarizing effect on respondents, but, notably, they failed to depolarize them as well.

In short, the experimental results presented here support the main findings from the aggregate time series analyses presented in the previous section. Partisan respondents – particularly Republicans – appear responsive to in-group and out-group party cues in their attitudes towards climate science. These effects are modest, but they are still remarkable given decades of partisan polarization that has already occurred on this question and the relatively thin nature of the treatments used here.

Discussion

Climate scientists, international politicians and political scientists alike have been perplexed that a sizable portion of the American public rejects climate science, particularly among Republican Party supporters. There have been a lot of theories about why this is the case. Some have pointed to the role of organized climate denialists and the prevalence of ‘false balance’ in news coverage, others have highlighted the importance of ideology and media framing. Taking a back seat until recently has been the role of party elites. All of these factors could very well influence climate attitudes in the isolation of a survey experiment, but this does not mean they are meaningful drivers of the dynamics of American climate skepticism and partisan polarization. We believe scholars need to also examine over time dynamics in the information environment to examine this question, which has been neglected thus far in research.

This paper situates climate change polarization in the larger literature on citizen cue-taking, media indexing, and opinion formation and persuasion. We find that the most consistent factor that predicts aggregate patterns of climate skepticism in the public, and among Republican supporters specifically, are cues from party elites – particularly Democrats. We find that cues from party elites lead rather than follow public opinion on this topic (H1) and that they are contemporaneously correlated with public opinion even after controlling for other factors scholars have deemed important in shaping attitudes towards climate change (H2).

These findings are strikingly supported by our survey experiment. We find that polarizing party cues from Democratic and Republican elites increased climate skepticism among Republican Party supporters. We found this to be the case with thin treatments and after decades of partisan polarization

has already occurred. We did not find a consistently similar effect among Democratic Party supporters, though we must sound a word of caution on this latter point. It is possible these results were hampered by a ceiling effect – Democratic supporters are already very supportive of the climate change consensus, so it is possible our treatments could not move the needle any further. Nonetheless, future research should explore possible asymmetry in Republican and Democratic responses to elite cues on climate change.

In short, we show that the story behind climate change polarization is similar to other political issues of the day: members of the public were exposed to a large volume of partisan messages on climate change as the issue grew in salience – in this case primarily from Democratic elites – and formed their opinions accordingly. This work joins an emerging literature on the role of the media and elite cues in climate change polarization (Carmichael and Brulle 2017; Guber 2013; Merkley and Stecula 2018; Tesler 2017), work showing the persuasive influence of out-group party cues (Berinsky 2009; Nicholson 2012) and research on the possibility of boomerang effects in science communication where messages designed to persuade may do the opposite for certain segments of the public (Hart and Nisbet 2012).

There are a number of important implications from these findings. First, party elites who strongly identify with the scientific consensus on climate change or other issues must weigh the costs and benefits of aggressively communicating their stance in the mass media. The rising prevalence of party elites in news coverage of climate change was inevitable at some level because of the need for large-scale policy action, but this finding has implications for other scientific issues, such as safety of genetically modified organisms (GMOs) and vaccines. Efforts to bring these issues into the realm of elite conflict will almost surely lead to polarization as an unanticipated consequence.

Second, emphases on ideology and motivated cognition, while important to understanding why persuading Republicans and conservatives about the perils of climate change is a tough task at present, is perhaps of more limited utility in helping us explain how we got to this point in the first place. Republican supporters were not always so skeptical of climate change. They listened to, and formed opinions based on, signals from trusted opinion leaders within their communities. By viewing the roots of climate change skepticism primarily in deep-seated ideological and value constructs, we minimize the degree to which elites can shape those constructs. It also means that these elites can turn the tide by taking climate change out of the realm of hyper-partisan conflict. Although our experiment did not find a de-polarizing effect of a consensus cue treatment, a stronger treatment featuring highly respected Republican officials may have more success.

Lastly, and relatedly, the potentially seminal role of party elites in the formation of public attitudes on climate change suggests scholars should invest less time and resources in identifying messaging strategies to mobilize support for the climate consensus, and more on understanding the motivations and behavior of party elites. Finding ways to mobilize an elite consensus across partisan lines is perhaps the most promising strategy to bring public opinion alongside the scientific consensus.

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