Beliefs about Climate Beliefs: The Problem of Second-Order Climate Opinions in Climate Policymaking

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Abstract

Even as the threat of climate change intensifies, political efforts to manage the climate crisis remain stunted. Many scholars position mass public opinion as one serious constraint on domestic and international climate policymaking. However, to date, climate opinion research has focussed predominantly on variation in the beliefs of individuals about global climate patterns and policies. By comparison, we know comparatively little about 'second-order' climate opinions: beliefs that individuals hold about the climate beliefs of other. This article examines the distribution and content of second-order climate opinions among the US and Chinese publics using a series of original surveys. We find that the general public in both countries believe their country's population is more divided in their climate beliefs than is true in reality. Further, second-order beliefs are egocentrically biased, with climate change disbelievers reporting systematically lower estimates of population-level climate beliefs. We extend our analysis to perceptions of climate beliefs in other countries, to anticipated compliance with the 2014 US-China Climate Accord, and to the rationales that individuals impute to the climate beliefs of others. Our results shed important new light on the dynamics of climate policy conflict by profiling an under-appreciated political barrier to climate policy action.

Over the past two decades, the threat of climate change has intensified. By the end of the century, global temperature increases, rising sea levels, and shifting precipitation patterns will threaten the economic and social well-being of citizens across the globe (IPCC, 2014). Many climate impacts are already being realized, even across advanced economies (Hansen *et al.*, 2012; Herring *et al.*, 2014). Yet, global efforts to mitigate the risks of climate change remain stunted. Global greenhouse gas emissions continue to grow, unabated, to levels that scientists believe will trigger dangerous anthropogenic climate change.

The inadequacy of social and political responses to climate change has prompted extensive investigation, with scholars pointing to such diverse factors as the to the absence of global institutions to coordinate climate policy action (Young, 2002; Keohane and Victor, 2011; Barrett, 2006; Urpelainen, 2012; Stern, 2007), the role of powerful business opponents (Layzer, 2007, 2012), issue salience (Rabe, 2004) and domestic distributive conflict (Stokes, 2015; Hughes and Urpelainen, 2015; Aklin and Urpelainen, 2013b) to explain variation in climate policy outcomes. Among these factors, many scholars emphasize the distribution of climate and energy opinions as one serious constraint on climate policy action (Druckman, 2013; Hughes and Urpelainen, 2015). This is because mass public opinion can shape the political incentives of power-seeking leaders to support particular policymaking agendas.

Recognizing the potential importance of public opinion to climate policy action, an emerging literature seeks to explain the drivers of climate and energy opinions across global publics (Scruggs and Benegal, 2012; Brulle *et al.*, 2012; Norgaard, 2011; Tranter, 2011). These efforts to describe and explain variation in the distribution of public climate opinions tend to emphasize the interpersonal nature of climate cognition, with climate beliefs shaped by communication among peers or from elites. However, individual beliefs about climate change are shaped not only by explicit communications between actors but also by the perceptions that individuals develop about the climate beliefs of other actors. As Robert Keohane (2015, pg. 24) writes: "Thinking about building a popular movement raises the issue of *beliefs*. For climate change to be sufficiently salient to generate support for costly action, voters need to have a widespread understanding that they are a part of a 'community of fate', whose members share a common understanding of the critical importance of this issue."

The establishment of such a community of fate depends not only on personal beliefs, the overarching

focus of climate opinion studies to date, but also on individuals' perceptions of the beliefs of others, our focus in this research. Surprisingly, we still know very little about 'climate common knowledge' and associated second-order climate beliefs: beliefs individuals hold about the climate beliefs of others. This paper begins to address this gap using new survey data from the United States and China. We examine beliefs about whether climate change is happening, whether humans are causing it, and the likelihood of compliance with November 2014 US-China climate agreement. We also look at levels of support for diverse climate policies. To investigate these topics, we report the findings from a variety of datasets, including nationally representative samples of the US and Chinese publics as well as a national survey of US International Relations scholars. Together, our results profile a critical but under-appreciated barrier to political action on climate change: the biased distribution of second-order climate beliefs. Broadly, we find that the extant distribution of second-order climate beliefs reinforces depressed levels of belief in climate change and modest support for climate policy action. Second-order climate beliefs thus reinforce weak political incentives to engage in ambitious climate policy reforms. Underscoring the importance of second-order climate beliefs to climate opinion, we also present the results of a survey experiment to show how, conversely, correcting second-order beliefs can increase support for climate policy action.

Beliefs about the Climate Beliefs of Others

Public climate and energy opinions are highly variable, both across countries (Kvaløy *et al.*, 2012; Kim and Wolinsky-Nahmias, 2014) and within countries (Howe *et al.*, 2015). At the same time, public concern about climate change is consistently lower than the level of concern among climate scientists and policy experts (Leiserowitz *et al.*, 2013; Dunlap and McCright, 2008; Gallup, 2009). This disconnect has prompted many scholars to describe the distribution of climate and energy opinions as one serious constraint on climate policy action to the extent that it reduces political incentives to propose and support climate reforms (Druckman, 2013; Hughes and Urpelainen, 2015). Claims that mass public opinion shapes climate reforms echo a diverse literature documenting the ways in which public policymaking is responsive to mass public opinion (Erikson *et al.*, 1993; Stimson *et al.*, 1995; Lax and Phillips, 2012;

Tausanovitch and Warshaw, 2014).

Efforts to explain the disconnect between the serious nature of climate risks and uneven public level of concern about climate change have tended to emphasize cognitive and emotional biases at the individual level. Scholars have elaborated a diverse set of reasons why the human mind is poorly adapted to thinking about climate risks (Weber and Stern, 2011). For instance, even trained experts struggle to identify the rational response to climate threats that involve feedbacks and time delays (Sterman, 2008, 2011). Scholars have also explored how public beliefs about climate change respond to a range of social and psychological cues, rather than to changes in knowledge about climate science. Various studies have described how climate attitudes are a function of elite political cues (Borick and Rabe, 2010; Brulle *et al.*, 2012), media content (Boykoff and Boykoff, 2004; Zhao, 2009; Feldman *et al.*, 2012; Boykoff, 2011), emotional self-regulation (Norgaard, 2011; Milkoreit, 2013), ideological biases (Feygina *et al.*, 2010), personal weather experiences (Egan and Mullin, 2012; Hamilton and Stampone, 2013; Howe and Leiserowitz, 2013), or cultural world views (Dryzek, 2013; Kahan, 2015). Still other work investigates how diverse framing and persuasion techniques can shape public beliefs about climate and energy reforms (Wood and Vedlitz, 2007; Aklin and Urpelainen, 2013a; van der Linden *et al.*, 2014).

However, the distribution of second-order climate opinions – beliefs that individuals hold about the climate beliefs of others – are also an important component of mass climate opinions. When political actors and national publics have biased perceptions of the climate beliefs of others, their tendency to support national or global climate policy action may increase or decrease, depending on the direction of the bias. In other words, second-order climate opinions can shape incentives associated with collective action at both domestic and international scales. To the extent that second-order climate beliefs systematically underestimate the true distribution of climate beliefs, we should generally expect that this will reinforce climate policy inaction at both domestic and global scales.

Collective action around climate change is shaped by problems of both cooperation and coordination (Keohane and Victor, 2016). Coordination requires political actors to agree on a set of common behaviors that, once enacted, can become self-enforcing. Cooperation requires political actors to agree on new institutions or modes of behavior that incentivize cooperation and disincentivize free-riding.

Climate coordination will be stymied when actors do not believe that coordinating efforts can be effective. For instance, actors may not invest scarce time or resources in political climate activism because they don't believe their efforts will help elect a pro-climate political official, will help pressure an existing official to support some pro-climate policy, or will help mobilize peers to engage in climate-friendly behaviors. By contrast, climate cooperation will be stymied when individuals retain an incentive to free-ride or believe that other actors may still free-ride. Generally, domestic climate politics are shaped by problems of coordination, while international climate politics are shaped by problems of both coordination and cooperation.[1]

Collective action explanations of the climate crisis emphasize that no actor has the unilateral capacity to manage climate change and/or the unilateral incentive to abate their carbon pollution. Crucial to achieving collective action in the face of such disincentives are beliefs about the beliefs of others (Chong, 1991; Uslaner, 2002; Ostrom, 2014). This is because outcomes in global games depend on perceptions of the pay-offs of others and, in turn, your perceptions of others' perceptions of your pay-offs; strategic uncertainty about these perceptions subsequently shape the potential equilibria available to players (Rubinstein, 1989; Morris and Shin, 2001).

Outside of the climate space, scholars have linked second-order beliefs to cooperation and coordination outcomes in a number of settings. For instance, Keltner and Robinson (1993) primed negotiations to believe there were differences between their own beliefs and the beliefs of others, when in reality, their beliefs were similar. They found this intervention made cooperation more difficult. Chambers and De Dreu (2014) found that egocentrically-biased beliefs about the interests of others can undermine attempts to mediate conflict. And a literature on conditional cooperators in public good games suggests that many individuals increase their contributions to public goods conditional on their expectations of the likely contributions of others (Fischbacher *et al.*, 2001; Frey and Meier, 2004; Ostrom, 2014).

These same considerations apply to climate politics. At the domestic level, individual incentives to act collectively will be depressed if they underestimate the willingness of others to also act; second-order beliefs may condition climate-related political behaviors, from willingness to support individually costly

[1]Strictly, cooperation in most domestic contexts is ensured by government enforcement of legislation; instead, climate policy inaction is a function of ineffective coordination within existing political and legislative processes.

climate reforms to an individual's willingness to invest time or money in climate advocacy campaigns. We can imagine a welfare-damaging equilibrium condition where individuals fail to coordinate even though they all individually desire some action because they believe that others do not share their willingness to act. More generally, power-seeking political leaders will be disinclined to support reforms of they do not believe these reforms enjoy the support of the general public.

At the international level, elite beliefs about the strategic knowledge and behavior of other countries shapes foreign policy decisions. At the same time, these elite decisions still depend on the beliefs and perceptions of national publics. A growing literature describes how domestic political considerations and public opinion constrain the range of international policies that political leaders support (Aldrich *et al.*, 1989; Milner and Tingley, 2015). In this way, US political actors may find themselves politically constrained when interacting with foreign governments if the US public believes that government will defect from a climate agreement, or if the US public believes that country has low levels of belief in climate change. Consequently, to the extent that national publics underestimate the distribution of climate beliefs in other countries, this might create indirect incentives for national political actors to underinvest in global collective action efforts. In sum, a complete understanding of second-order climate beliefs also requires an understanding of what national publics think about the distribution of beliefs among other global publics.

The broad consequence of these considerations is that efforts to study the political incentives associated with climate policy action depend not just on the first-order distribution of climate beliefs, but also the more complex expectations that individuals have about the climate beliefs of others. The nature of this distribution is ultimately an empirical question. To date, we have had only a limited understanding of second-order climate beliefs about climate change. Some scholars have documented how individuals systematically underestimate the fraction of the US population who believe that climate change is happening (Leiserowitz *et al.*, 2013). However, it has only been recently that scholars have begun to interrogate second-order climate beliefs in detail. Building from theories of the false consensus effect, Leviston *et al.* (2013) find that Australians overestimate the proportion of the population who share their views on climate change, and systematically underestimate the true fraction of the Australian

population who believe that climate change is happening. In a separate Australian study of federal politicians, Fielding *et al.* (2012) find that most elected officials believed their own climate attitudes were more pro-climate than their electorates; the one exception were right-leaning politicians who reported personal beliefs that corresponded to their perceptions of the distribution of beliefs in their electorates. Finally, in an experimental study of US climate attitudes, individuals with depressed estimates of the climate beliefs of others were less likely to communicate their beliefs to others; fearing social sanctions, willingness to discuss climate beliefs increased when researchers provided subjects with information about the true distribution of climate beliefs (Geiger and Swim, 2016).

These findings suggest the potential importance of second-order climate beliefs to a full understanding of climate opinion dynamics. However, much work remains. For instance, we still need to understand variation in second-order climate beliefs across countries[2] and with respect to different politically-relevant subpopulations. Further, existing research has measured second-order climate opinions exclusively by asking respondents to numerically estimate population-level agreement or disagreement with particular beliefs (Leviston *et al.*, 2013; Fielding *et al.*, 2012). It is equally important to understand the content of individual beliefs about the climate beliefs of others, particularly the complex rationales that individuals construct to make sense of the beliefs of others. Ultimately, it is only with a rich understanding of the distribution of beliefs and expectations around climate change policy that we can develop a full understanding of the political conditions necessary to support a climate policy response.

Research Design and Predictions

This paper explores the empirical distribution of second-order beliefs using questions fielded in a series of national surveys in the United States and China between 2014 and 2015. These data sources are presented Table 1, along with the sections of our results that draw from each survey source.

Our US survey data draws from four separate data sources. Our first and second sources were nation-

[2]Both Leviston *et al.* (2013) and (Fielding *et al.*, 2012) were conducted in Australia. The issue of climate change is exceptionally politicized in Australia, the result of intensive public conflict over climate policy during the past decade (c.f. Hamilton, 2007; Burgmann and Baer, 2012). Since we might expect that the high public salience of climate change shapes the mechanisms through which climate beliefs are imputed, it is important to ensure that Leviston's and Fielding's basic results replicate in samples of the US public.

Table 1: Overview of survey data described in this article

Date	Sample	Provider	n	Results presented in:
March 2014	US population	Survey Sampling International (SSI)	1815	Fig 1
May 2014	MTurk workers	Amazon Mechanical Turk	1131	Fig 3; Fig 7
February 2015	Chinese population	Survey Sampling International (SSI)	1659	Fig 2; Fig 4
March 2015	US population	Survey Sampling International (SSI)	2073	Fig 5; Survey experiment
March 2015	IR scholars	TRIP Snap Poll	1054	Fig 6

ally representative surveys of the US public. First, we included questions on a nationally representative survey conducted by Survey Sampling International (SSI) of Shelton, CT (n=1815) in March 2014. We also included questions in a national representative survey conducted by SSI (n=2073) in March 2015. Survey Sampling International conducts internet surveys from opt-in recruits, and has been widely used within political science research (e.g. Healy and Lenz, 2014; Malhotra and Margalit, 2010; Kertzer and Brutger, 2015; Iyengar and Westwood, 2014).

Third, we fielded a standalone survey during May 2014 using Amazon's Mechanical Turk service (n=1131). MTurk is an online marketplace that allows researchers to post surveys and other small tasks that to be completed by eligible workers. Mechanical Turk populations are not nationally representative; however, they outperform other forms of convenience-based opinion sampling along a variety of dimensions (Berinsky *et al.*, 2012; Buhrmester *et al.*, 2011). Mechanical Turk samples have a well-studied liberal bias, which correlates with pro-climate beliefs in the US context. We used an innovative sampling method to manage this bias in this study. Specifically, we drew our samples from a pre-existing database of Mechanical Turk responses that were collected by the authors in previous work. This database included responses to previous questions about respondents' climate change opinions.[3] We invited 2003 Mechanical Turk workers with known climate priors to take our new surveys. Of these invited workers, 1001 had previously indicated that they believed climate change was happening and 1002 had previously indicated they did not. We received 1131 complete surveys, a response rate of 56.5%. This procedure gave a decidedly better balance on individual-level climate beliefs than would have been the case if we had relied

[3]In these previous Mechanical Turk surveys, respondents were asked: "Global warming refers to the idea that the world's average temperature has been increasing over the past 150 years, may be increasing more in the future, and that the world's climate may change as a result. What do you think? Do you think that global warming is happening?"

on an opt-in sample from the general Mechanical Turk population. However, as with all MTurk samples, we should not expect our data to be nationally representative. All respondents were US residents who had over a 95% approval rating from previous Mechanical Turk tasks.

Fourth, we fielded two questions about compliance with the US-China Climate Accord in a Teaching, Research and International Policy (TRIP) Snap poll in March 2015 (n=1054). The TRIP poll periodically surveys IR professionals about topics in current affairs.[4]

Fifth and finally, we also fielded questions in a nationally representative internet-based survey of the Chinese public in February 2015, again using the firm Survey Sampling International (n=1659). This survey used quota sampling procedure to achieve an approximately nationally representative sample based on gender, age, and region in China. The survey was translated from English to Mandarin by native speakers and then back-translated. Differences between the questions asked in the Chinese and US surveys are detailed in the following section.

Survey Questions

Here, we introduce the five survey sections that form the basis for our core analysis.

First, we collected data on individual perceptions of domestic climate beliefs. In our March 2014 SSI survey of the US population, we presented each respondent with three climate-themed statements: 1) Global warming is happening; 2) Global warming is caused by human activity; 3) Most scientists think global warming is caused by human activity. We asked for respondent agreement or disagreement with these statements along a four point scale from Strongly Agree to Strongly Disagree. Then, for each statement separately, we asked respondents: "To the best of your knowledge, what percentage of the U.S. population would AGREE with the statement that [statement]. Type a number from 0 (no one) to 100 (everyone)." In our MTurk surveys and in our March 2015 SSI survey of the Chinese population, we presented each respondent with a set of four climate-themed statements: 1) Global warming is happening; 2) Global warming is caused by human activity; 3) The [United States/China] should pass a policy to increase the cost of carbon pollution; and 4) The [United States/China] should sign an international

[4]The TRIP survey series is an opt-in survey that is sent to a large database of international relations scholars and maintained at William and Mary (`http://www.wm.edu/offices/itpir/trip/`).

treaty that requires the [US/China] to cut its emissions of carbon dioxide 90% by the year 2050. Again, for each statement separately, we asked respondents: "To the best of your knowledge, what percentage of the [American/Chinese] population would AGREE with the statement that [statement]. Type a number from 0 (no one) to 100 (everyone)."[5]

Second, in our MTurk surveys, we asked a series of open-ended questions about the rationales that individuals attributed to the climate beliefs of others. Our first prompt dealt with whether or not climate change is happening and read: "Some people in the United States believe that climate change is not happening. Other people think that climate change is happening. We would like for you to imagine you are talking to a group of colleagues who do [do not] believe that climate change is happening. Imagine you asked each of them why they do believe climate change is [is not] happening. What do you think they would tell you? Please write several sentences, focusing on what you think their responses would be. They would say..." Individuals in our survey were randomly assigned to speculate as to the rationales of those who do believe or those who do not believe that climate change is happening.

Third, we collected data on individual perceptions of climate beliefs among foreign publics. For both US and Chinese surveys, we used the four-statement set described above. In our US MTurk surveys, we randomly assigned respondents to estimate the fraction of the US or Chinese population that agreed with each statement. We use a between-subject analysis here to avoid concerns that individuals will anchor their responses on their in-group (domestic) estimate when estimating the subsequent distribution of second-order climate beliefs. In our Chinese SSI survey, we randomly assigned the order in which respondents were asked to estimate domestic (Chinese) or foreign (US) beliefs.

Fourth, we collected data on US perceptions of the likely compliance of both the United States and China with the 2014 US-China Climate Accord. To do so, we fielded identical questions among a nationally representative survey of the US population in the March 2015 SSI survey and among IR experts in the March 2015 TRIP poll. For each poll, respondents were provided with the following information: "In November 2014, the United States and China announced an agreement to work together to solve

[5]In this last question, respondents were either asked about the US passing a policy that required the US to cut emissions, or China passing a policy that required China to cut emissions. We did not ask any cross-cutting conditions (e.g. US passing a policy that required China to cut emissions.

the threat of global warming. President Obama announced the US would cut its carbon pollution 26% by the year 2025. China agreed to stabilize its carbon pollution levels by 2030 and meet 20% of its energy needs through clean renewable energy by 2030. The announced goals were voluntary." We asked respondents whether they agreed or disagreed that each country "will meet its carbon pollution reduction and clean energy goals from the November 2014 agreement". We then asked respondents: "To the best of your knowledge, what percentage (from 0 to 100) of [Chinese/American] citizens would agree with the following statements? 1) The United States will meet its carbon pollution reduction goals from the November 2014 agreement; 2) China will meet its carbon pollution reduction and clean energy goals from the November 2014 agreement."

Fifth, we embedded a survey experiment within the March 2015 nationally representative survey of the US public. In this experiment, we provided a random subset of respondents with the true Chinese distribution of climate beliefs. These respondents read, "According to recent nationally representative polling in CHINA, 98% of the CHINESE population believes that global warming is happening." In this way, we randomly treated our sample with the true distribution of climate beliefs in China, as measured by our February 2015 SSI Chinese survey data.

Results

First, we summarize the distribution of within-country second-order climate beliefs. This section summarizes how American and Chinese publics perceive climate beliefs and climate policy support within their own countries. Second, we summarize between-country second-order climate beliefs. This section summarizes the perceptions of American and Chinese publics about the distribution of climate beliefs among the other country's population. Third, we present results from an experimental effort to shift second-order beliefs to increase support for collective climate action. Fourth and finally, we examine the distribution of rationales that individuals ascribe to the beliefs of others.

Within-Country Results

The results of our surveys revealed a consistent pattern among second-order beliefs: people underestimate the percentage of the population with pro-climate beliefs. Figure 1 summarizes the average estimates of the fraction of the US population that agrees or disagrees with three climate statements, collected from a nationally representative SSI survey fielded in March 2014. We find that both climate change believers and disbelievers systematically underestimate the true level of pro-climate beliefs for all three statements.[6]

Despite a general tendency to overestimate the number of climate disbelievers, the US public also display substantial egocentric bias across a range of different climate beliefs and climate policy preferences. By egocentric bias, we mean that an individual's personal beliefs systematically shape their perceptions of group beliefs. We find that individuals condition their second-order climate beliefs on their personal agreement or disagreement with each statement: those who individually disagree with a statement report systematically lower estimates of population-level agreement with that statement.[7] Further, we find evidence of similar egocentric bias and similar global underestimation of climate beliefs across different education levels (results provided in the SI). These results replicate findings from Leviston *et al.* (2013) for the first time in a US context. In the Supplemental Analysis section, we further explore differences in second-order climate beliefs among partisans. We find that pro-climate Republicans systematically overestimate the number of Republicans who are pro-climate; however, anti-climate Republicans and all Democrats hold otherwise homogenous second-order order beliefs about the partisan distribution of climate opinions.

We find similar results in a nationally representative survey of the Chinese public, fielded by SSI in February 2015.[8] The belief in climate change and support for select climate policies are higher, in an

[6]Individuals who declared that they "didn't know" whether global warming was happening were coded as disagreeing with the statement. When disaggregated, the second-order beliefs about climate change of those who answered "don't know" were identical to those who disagreed. This likely corresponds to the increased use of a "don't know" response among climate change opponents. For instance, senior Republicans have begun to avoid taking a position on climate change change by emphasizing that they are "not a scientist" and thus don't know if climate change is happening or not. Overall 189 respondents (10.1% of the sample answered "Don't Know".

[7]Of course, the true level of belief in climate change varies with question wording across surveys. We should expect that estimates of the distribution of climate opinion may also change as a result of different framing conditions and word choices. Yet, our results compare second-order beliefs to nationally representative estimates of support for identically worded survey questions at a single point in time.

[8]The Chinese survey did not offer a "Don't Know" option. All respondents reported the level of their beliefs in climate

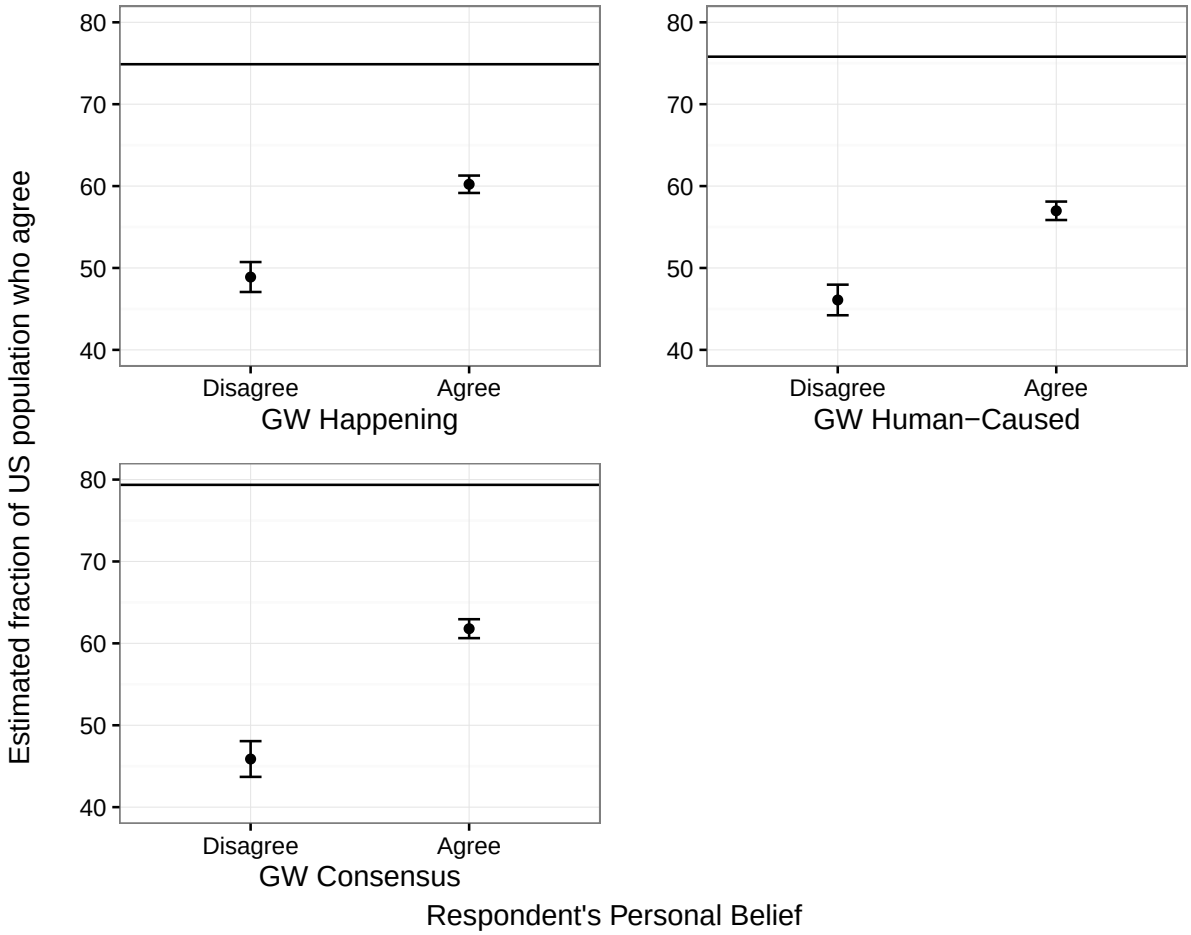

Figure 1: Estimates by US citizens of US population agreement with statements about climate change, conditional on a respondent's reported personal beliefs. *GW Happening* = "Global warming is happening." *GW Human-Caused* = "Global warming is caused by human-activity." *GW Consensus* = "Most scientists think global warming is caused by human activity." The horizontal line on each graph gives the true population agreement with each statement (as estimated by March 2014 nationally representative SSI survey of the US population). Error bars give the 95% confidence interval.

absolute sense, in China than in the United States. However, the Chinese public similarly underestimates the fraction of the Chinese population that support climate-related statements.[9] We also find similar evidence for egocentric bias in the second-order climate beliefs within the Chinese population. Chinese respondents who personally agree with particular statements estimate that a larger fraction of the Chinese population agrees with that statement than those who personally disagree.

change.

[9]Note that since the baseline level of belief that global warming is happening in China is high, the sample who disagree with this specific statement is small, resulting in the large sampling errors for this population. We obtain similar results with tighter confidence intervals if we compare individuals who somewhat agree versus those who completely agree.

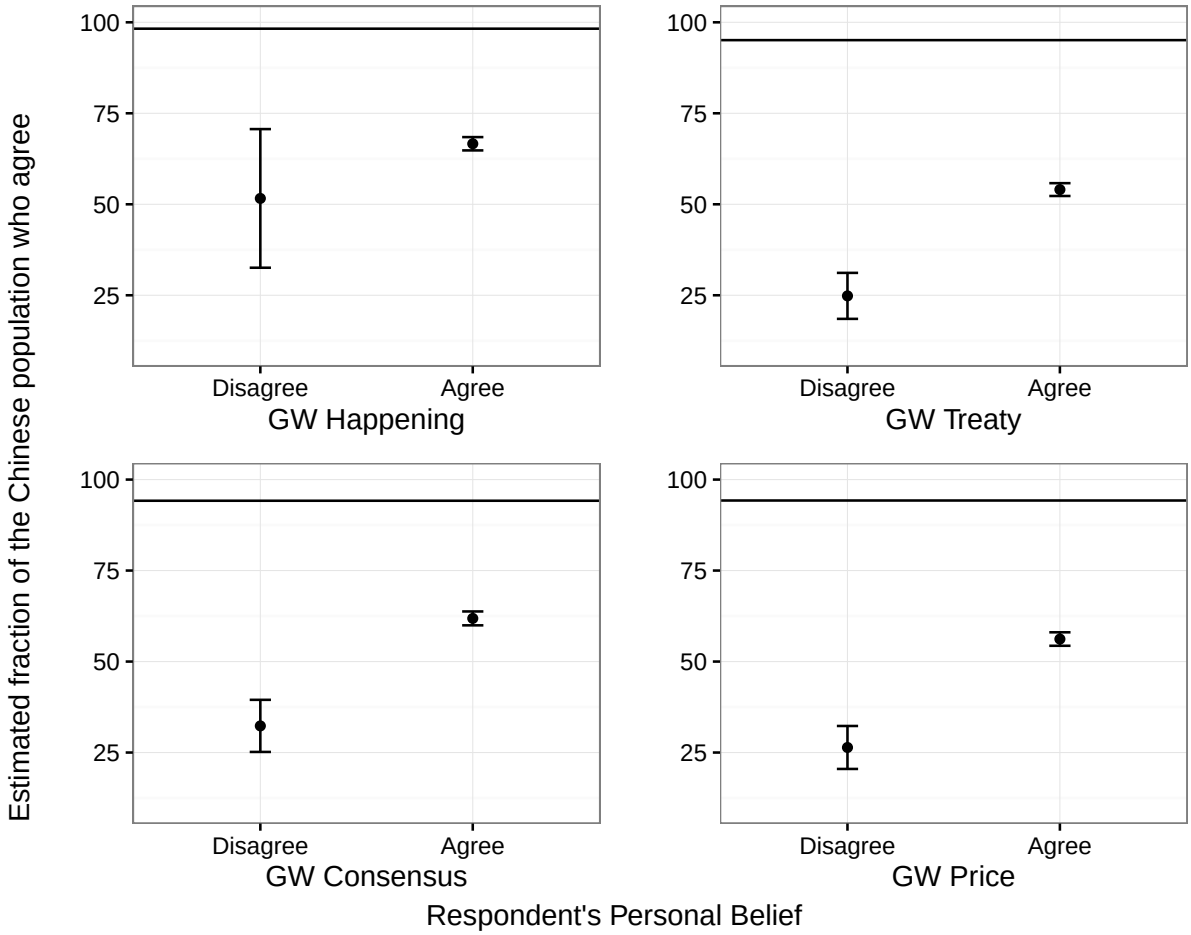

Figure 2: Estimates by Chinese citizens of Chinese population agreement with statements about climate change, conditional on a respondent's reported personal beliefs. *GW Happening* = "Global warming is happening." *GW Consensus* = "Most scientists think global warming is caused by human activity." *GW Treaty* = "China should sign treaty requiring 90% cuts by 2050." *GW Price* = "China should put a price on pollution." The horizontal line on each graph gives the true national level of agreement with these statements (as estimated by March 2015 nationally representative SSI survey of the Chinese population). Error bars give the 95% confidence intervals.

Between-Country Results

Next, we explore US and Chinese perceptions of climate beliefs in the other country. Figure 3 contrasts US perceptions of the distribution of climate beliefs in the United States with US perceptions of the distribution of climate beliefs in China. The data here comes from a non-representative survey using MTurk.[10] Again, the data is presented conditional on a respondent's personal beliefs. Americans broadly

[10]We do not reweight our MTurk data because we are interested here in perceptions of US and Chinese climate beliefs relative to one another. As a result, the absolute levels of support for each climate statement are not identical to the nationally representative estimates presented in Figure 1. Overall, sample support for the statement: "global warming is

perceive that the Chinese public has lower support for climate-science related statements than does the US population. At the same time, they perceive the Chinese population as believing that US support for policy action is stronger than Americans themselves believe.[11] This data also provides suggestive evidence of declines in egocentric bias when estimating Chinese as opposed to US population agreement with climate-related statements. That is, the gap between what those who agree and those who disagree report as second-order beliefs is smaller when estimating China as opposed to the United States.

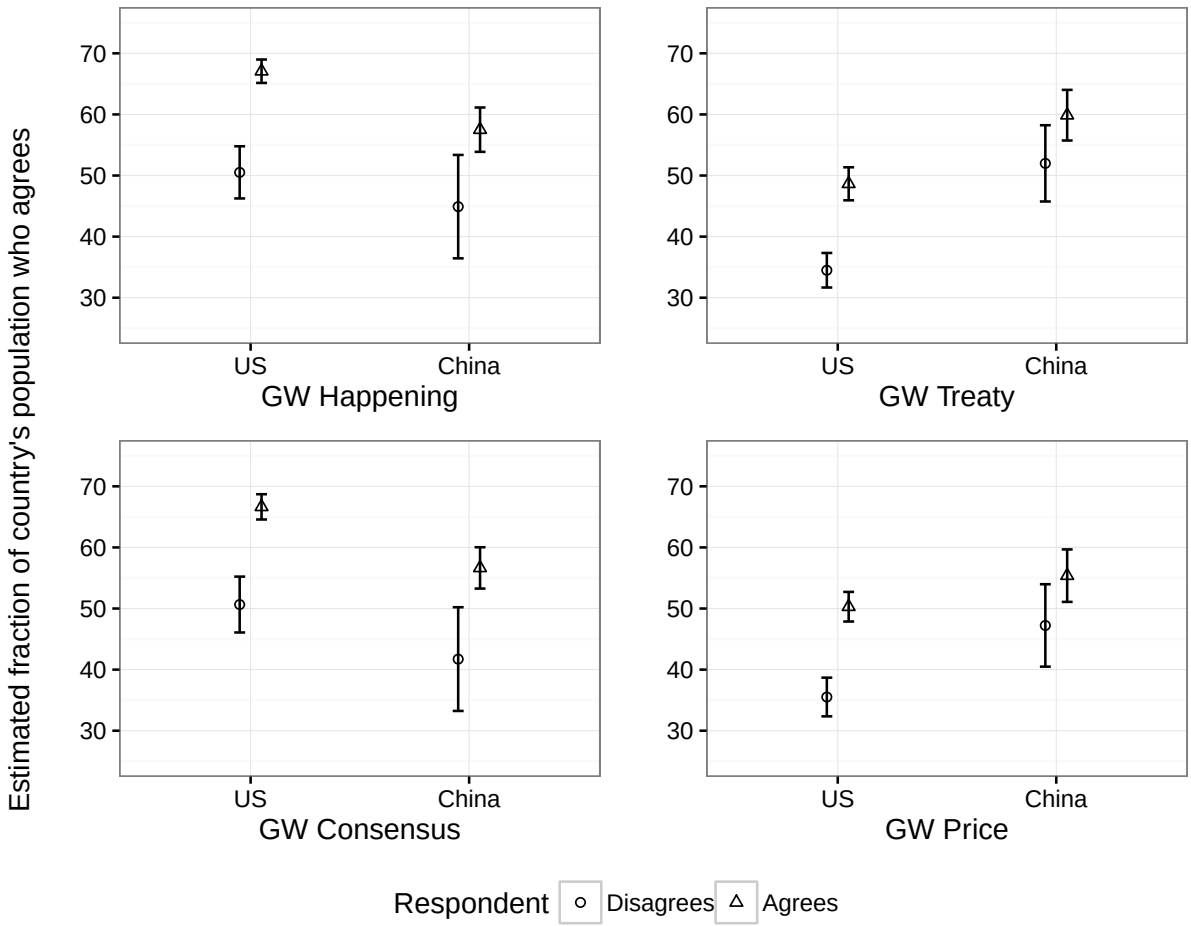

Figure 3: Estimates by US citizens of US and Chinese population agreement with statements, conditional on a respondent's personal beliefs. *GW Happening* = "Global warming is happening." *GW Treaty* = "US should sign a treaty requiring 90% cuts by 2050." *GW Consensus* = "Most scientists think global warming is caused by human activity." *GW Price* = "US should put price on a pollution." Error bars give the 95% confidence interval.

happening" was 75% in the March 2014 survey but was about 82% in our MTurk sample.

[11] Note, importantly, that this figure is providing an estimate of US beliefs about Chinese support for *US* policy action, not US beliefs about Chinese support for *Chinese* policy action.

We replicate this analysis in reverse in Figure 4, using a nationally representative sample of the Chinese population. Here, we estimate Chinese perceptions of the distribution of climate beliefs in both China and the United States, conditional on personal beliefs. Unlike the US case, we see only minimal reduction of egocentric bias when estimating population beliefs of the outgroup (now the US) when it comes to whether or not global warming is happening. However, there is a small reduction in egocentric bias when it comes to the question about the scientific consensus around climate change. We see strong attenuation of egocentric bias for the policy questions. In this way, the Chinese population mirrors the US population with its pattern of attenuated egocentric bias when estimating the policy preferences of the other country's public.

Finally, we examine second-order beliefs concerning compliance with the 2014 US-China climate accord. Our sample is drawn from a subset of our March 2015 SSI survey that was the "control" group in an experiment we describe shortly. Figure 5 gives US estimates of US and Chinese beliefs about US and Chinese compliance with the accord. The top left pane focuses on beliefs about the percentage of Americans that think the US will comply. In this survey, 64% of Americans believe that the US will comply with the treaty. However, individuals who do not believe the US will comply believe that on average only 40% of Americans expect their country to comply. And while this figure is greater for those individuals who think the US will comply (59%), it is still lower than the actual percentage. This finding, of underestimating population-level support but in a way that is conditional on one's own belief, parallels what we reported earlier. The top right pane of Figure 5 focuses on the percentage of Americans that think China will comply. Here, as represented by the vertical line, only 47% of Americans believed that China will comply (compared to 64% believing that the US will comply). Individuals who themselves do not think China will comply were particularly pessimistic about Americans as a whole thinking China will comply. Individuals who do think China will comply slightly overestimated the actual percentage who think so among the population, representing the more traditional form of egocentric bias.

By contrast, the lower two panes of Figure 5 gives US estimates of *Chinese* beliefs about US and Chinese compliance with the accord, again using data from our March 2015 SSI sample. Overall, Americans expect Chinese citizens to think that US compliance is *less* likely than Chinese compliance. Similarly,

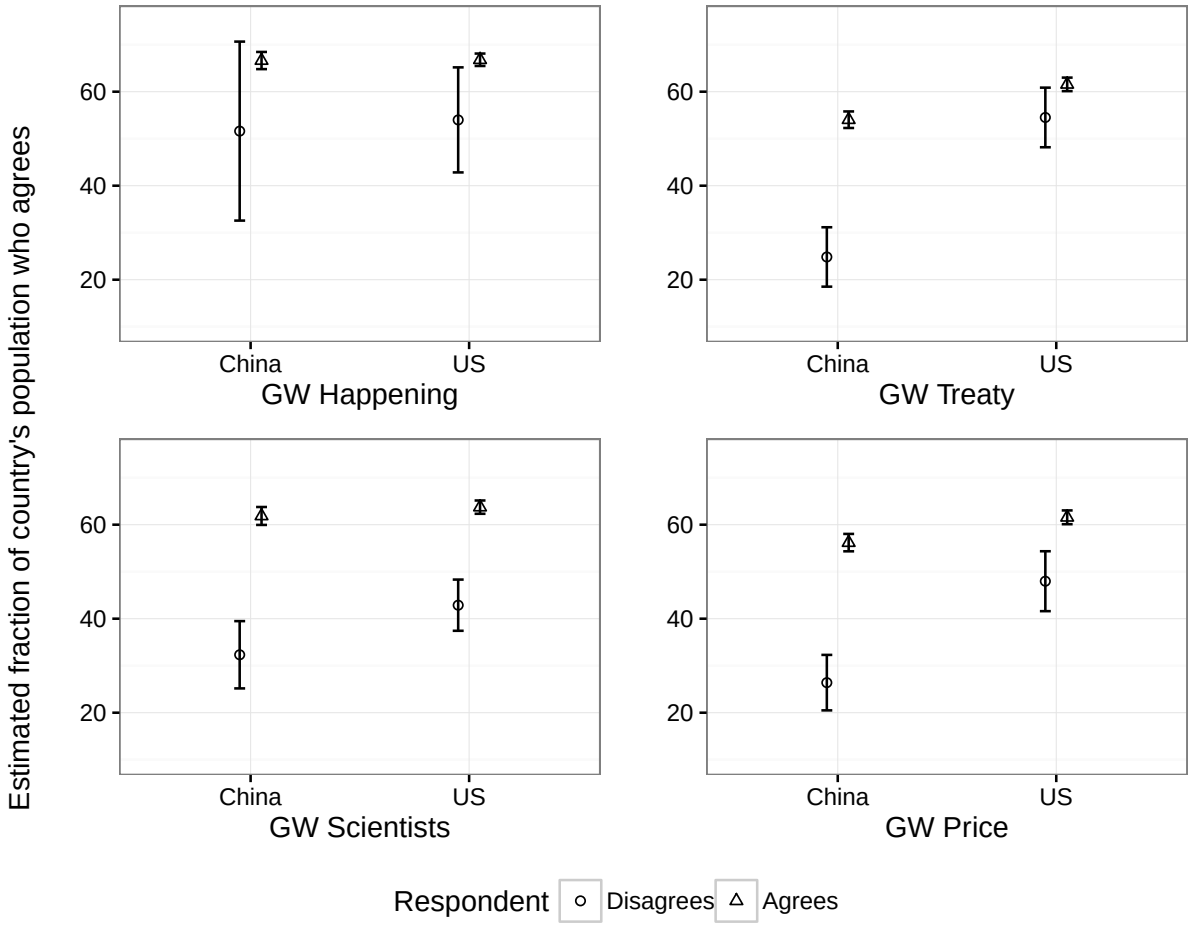

Figure 4: Estimates by Chinese citizens of Chinese and US population agreement with statements, conditional on a respondent's personal beliefs. *GW Happening* = "Global warming is happening." *GW Consensus* = "Most scientists think global warming is caused by human activity." *GW Treaty* = "China should sign treaty requiring 90% cuts by 2050." *GW Price* = "China should put price on pollution." Error bars give the 95% confidence interval.

Americans think that Chinese respondents will perceive China as *more* likely to comply than the US.

We also consider estimates by US IR scholars of *US* beliefs about US and Chinese compliance with the accord. While we do not have data for policy elites involved in negotiating international agreements, IR experts are drawn from the same community of experts that shape US foreign policy decisions. We should also expect that most IR scholars will be more familiar with the logic of the collective action challenges with respect to climate change. In sum, surveys of IR scholars offers a partial window into whether policy elites have systematically different perceptions of the distribution of climate opinion when compared to the general public, including whether general public biases are attenuated among active

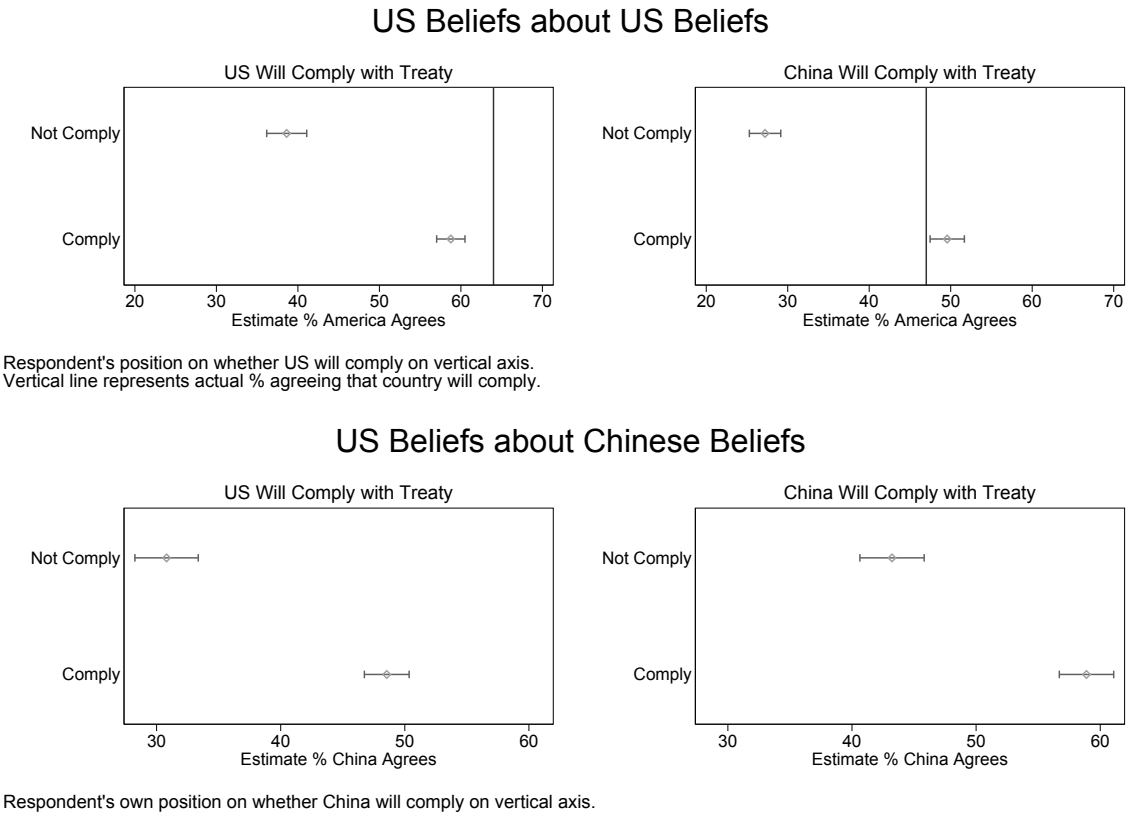

Figure 5: Estimates by US citizens of US and Chinese compliance with the US-China Climate Accord. Error bars give the 95% confidence intervals.

policy influencers.

Our results appear in Figure 6, which parallels the structure of Figure 5 and is taken from the March 2015 TRIPS survey. The solid vertical line gives the percentage of IR scholars that think each country will comply. We again see that expectations of US compliance are greater than expectations of Chinese compliance (48% versus 37%). The dashed lines represent the average percentage of Americans thinking that each country will comply (these are the same as the solid lines in Figure 5). International relations scholars are decidedly more pessimistic about compliance than is the US public. At the same time, we again see evidence of egocentric bias, even among policy elites. IR scholars who believe each country will comply report a larger estimate of the US public that thinks each country will comply, compared to IR scholars who don't think each country will comply.

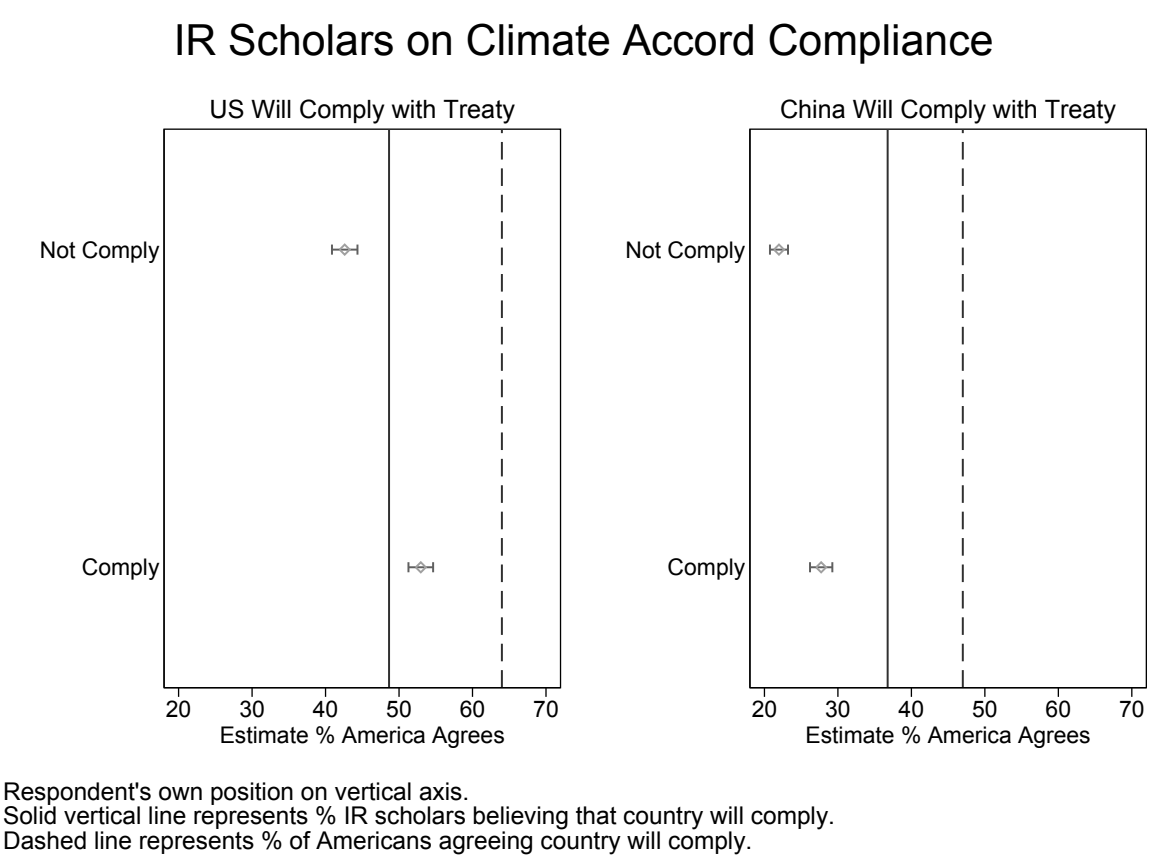

Figure 6: Estimates by IR scholars of US and Chinese compliance with the US-China Climate Accord. Respondent's own position on vertical axis with population % in parentheses. Vertical line represents % agreeing that country will comply. Error bars give the 95% confidence intervals.

Shifting Second-Order Beliefs

In this section, we take our analysis a step further by investigating results from an experimental effort aimed at directly evaluating the effect of second-order beliefs on support for collective action. As described above, in the March 2015 SSI survey of the US public, we provided a random subset of respondents with the true Chinese distribution of climate beliefs. These respondents read, "According to recent nationally representative polling in CHINA, 98% of the CHINESE population believes that global warming is happening." In this way, we randomly treated our sample with the true distribution of climate beliefs in China, as measured by our February 2015 SSI Chinese survey data. On average, exposing individuals to this information increased support for the treaty by 0.35 on our compliance scale which, while relatively

small, was significantly different from zero.[12]

While this effect is interesting in its own right, we were particularly interested in understanding whether shifting second-order climate beliefs would a) have an impact on expectations about Chinese government compliance with the US-China Climate Accord and b) if these beliefs influenced support for the US signing the agreement. This sets up a mediation analysis (Imai *et al.*, 2011). Does the effect of our treatment on support for the climate agreement operate through changes in second-order beliefs about Chinese compliance? Our mediator was measured by asking, "To the best of your knowledge, what percentage (from 0 to 100) of Chinese citizens would agree with the following statement? China will meet its carbon pollution reduction and clean energy goals from the November 2014 agreement."

We estimated the mediation effect using the medeff routine described in Hicks and Tingley (2011), with linear models for both the mediator and outcome variables.[13] Results show an average causal mediation effect of .09 (with a 95 percent confidence interval of 0.06 to 0.14). Nearly 40% of the average treatment effect can be attributed to changes in second-order beliefs about expectations about Chinese compliance. We thus find that there is a very strong mediation effect on the support for the climate accord as a function of treatment of the respondent's second-order beliefs. These results provide one perspective on how second-order beliefs impact international collective action on climate change.

Measuring the content of second-order climate beliefs

Thus far, we have reported results that explore individuals' perceptions of *what* views are held by others. This section considers the *why*. That is, we want to know what people think the reasons are that other individuals–perhaps ones that do not share their views–would give for their views. To do this, we asked our respondents to respond in an open-ended manner and write as if they were an individual who took a specific view on a climate change topic.[14] Then, we performed textual analysis on those open-ended responses in order to see if the topics people wrote about differ depending on the survey respondent's

[12]This average treatment effect of course masks heterogeneous treatment effects. For example, this effect was smaller among conservatives.

[13]As discussed in Imai *et al.* (2011), the core challenge to making causal inference in the mediation framework is that there may exist unobserved confounders that impact both the mediator and outcome variables. To guard against this possibility, we included controls for gender and, most importantly, whether the individual thought that humans are actively causing global warming.

[14]Details of these open-ended questions were described in the survey design section above

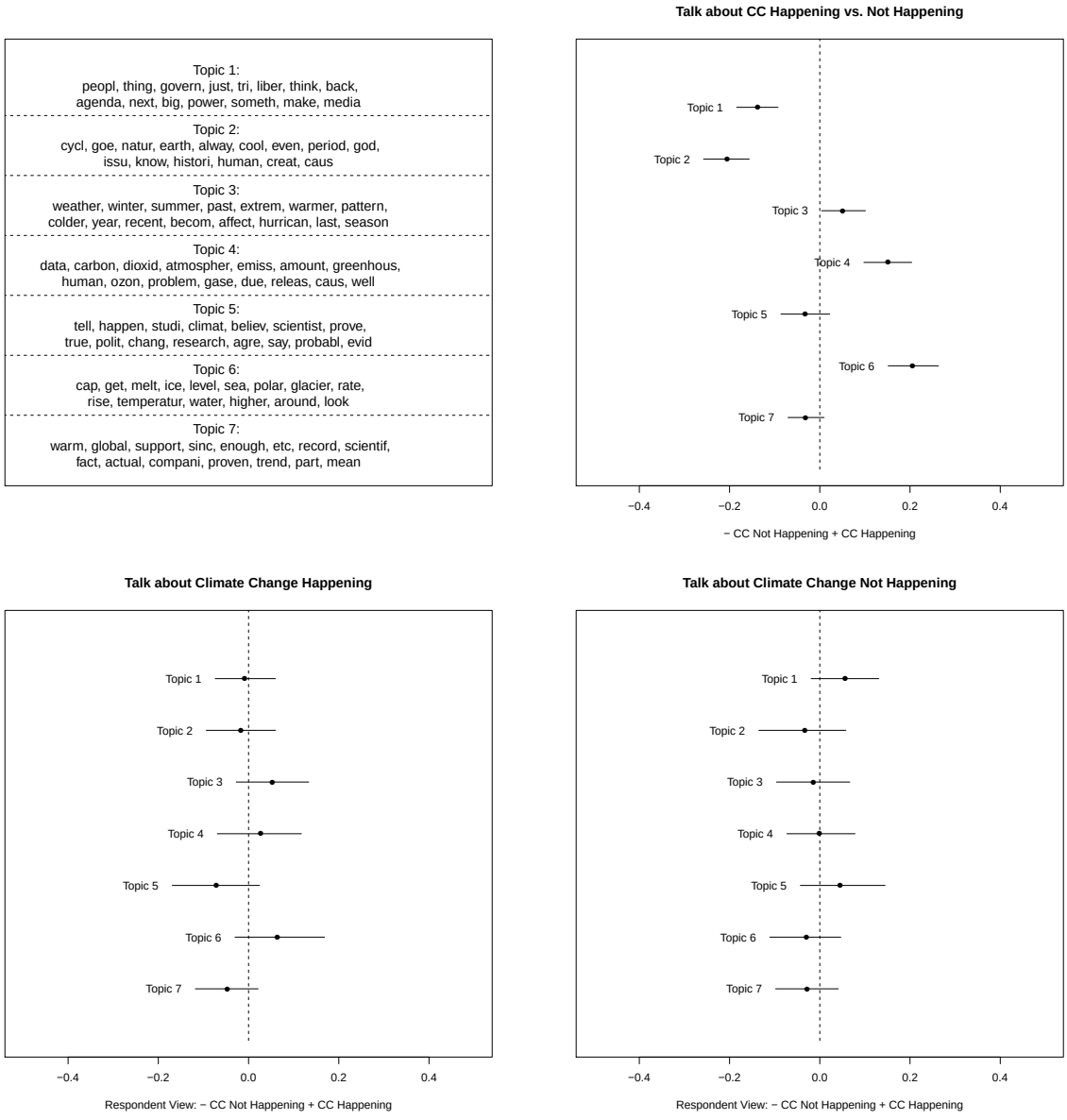

Figure 7: Top left of figure lists words highly exclusive to each topic. Top right gives the topic contrast between those who were asked to provide rationales for why others think climate change is happening and those asked to explain why others think climate change is not happening. Bottom half of figure plots the relationship between topics and respondent's own views on whether climate change is happening. The left hand plot is for people who were asked to write about an individual who thinks climate change is happening, and the right plot for people who were asked to imagine someone who did not think climate change is happening. The lines in the plot represent 95% confidence intervals for the *difference* between respondents who themselves think climate change is versus is not happening. Effects that are further to the left more likely to be mentioned by an individual who does not believe climate change is happening. Effects that are further to the right more likely to be mentioned by an individual who does believe climate change is happening.

belief of whether or not climate change is happening.

To analyze this open-ended data we utilize the Structural Topic Model (STM) (Roberts *et al.*, 2014), which has recently shown great promise in analyzing open-ended survey data. The STM is a type of "topic model" that discovers common co-occurrences of words and groups them into topics. An advantage of the STM over earlier topic models is that it investigates whether a covariate related to each document explains a propensity to talk about particular topics. In our case, we are interested in knowing whether individuals in our survey who differ in their climate beliefs also differ in the rationales they expect others would give to explain their climate change beliefs. For example, in responding to a prompt to explain why *another* person holds the view that climate change is happening, would an individual who thinks that climate change is *not* happening give the same response as someone who thinks climate change *is* happening?

To answer this question, we estimated a seven-topic STM with three topic prevalence parameters: whether the respondent thinks climate change is happening or not, whether the respondent got the prompt about others' rationales for their climate change beliefs, and an interaction between these two variables. Figure 7 plots the results. The top left of the plot provides a list of words for each topic that are highly exclusive with the topic.[15] These words help to discern differences between the topics. For example, Topic 1 deals with the influence of the liberal agenda on government. Topic 2 is about how climate change is a naturally occurring pattern that has happened before and can happen again. Topic 7 deals with generic scientific claims. The top right gives the contrast between those who were asked to provide rationales for why others think climate change is happening and those asked to explain why others think climate change is not happening. The bottom half of the figure plots the relationship between topics and respondents' own views on whether climate change is happening.

The differences in the rationales offered by those who believe climate change is happening and those who do not were substantively small and in every case statistically insignificant. While a larger sample would likely reduce our confidence intervals, the point estimates of the differences were also small. This suggests that individuals on both sides of this issue have similar beliefs about the rationales that others

[15] We use standard stopword and stemming procedures. As such our figures contain stemmed words.

might draw on when substantiating their views. We take this as evidence in support of there being common knowledge about rationales. In the Supplemental Information, we present results for a political actor prompt that asked respondents to suggest the rationales that a politician might have for believing or disbelieving in climate change. Again, we see no substantial differences across individuals in our survey. Thus overall, we find that differences in climate beliefs do not translate into a tendency to believe that others would invoke one rationale over another for their position.[16] Hence while this paper documents substantial differences in second order beliefs about aggregative opinion, there are less differences when it comes to the content of these beliefs. For those wishing to promote an agenda to take action on climate change, it is possible that this shared understanding of rationales could facilitate future discourse that is informed scientific facts and basic evidence from polls.

Discussion

Noting the lack of systematic attention to the politics of climate change, several political scientists have called for more research on this topic (Javeline, 2014; Keohane, 2015). Rather than study the propensity to free ride or cooperate (if others cooperate) (e.g., Tingley and Tomz, 2013) or responses to cost and institutional design issues (Bechtel and Scheve, 2013), we focus on beliefs. Our purpose with this paper is to deepen our understanding of the political constraints on climate policy action by focusing on "second-order" beliefs: beliefs that individuals have about the climate beliefs of others.

Drawing from a range of new survey data, our review finds systematic evidence that the public holds inaccurate second-order beliefs about the distribution of climate opinions and policy preferences among publics in their own country and publics abroad. Further, we find that many second-order climate beliefs are conditioned by respondents' personal beliefs, suggesting the presence of egocentric bias in second-order climate beliefmaking. While previous work has demonstrated similar results for the Australian public, we find the first evidence for systematic biases in the United States and China, the planet's two largest carbon polluters. Respondents in both countries underestimated the fraction of their own country's

[16] Topic models require setting the number of topics ex ante. We generally found results similar to those discussed below using other numbers of topics. We also estimated an STM using the methods described in Mimno and Lee (2014), which selects the number of topics based on t-distributed stochastic neighbor embedding. We again come to similar conclusions.

population who agreed with a variety of climate-related statements. At the same time, respondents also revealed egocentric biases in their estimates of these beliefs. When asking respondents to estimate the distribution of climate beliefs among foreign publics, an even more complex distribution of second-order beliefs emerged. Broadly, individuals in both China and the US believe that foreign publics are more supportive of policy actions than those foreign publics perceive themselves to be. Individuals also showed less evidence of egocentric bias when estimating the distribution of beliefs among foreign publics.

Our findings are consistent with a growing literature in social and cognitive psychology that examines the processes through which individuals impute the beliefs of others. Scholars have variously found that individuals overestimate the degree to which broader populations agree with their own personal beliefs (Ross *et al.*, 1977; Marks and Miller, 1987); assume that people who disagree with them have biased beliefs (Ward and Lee, 1997; Pronin, 2007); believe there is more polarization between their own beliefs and the beliefs of others than is true in practice (Robinson *et al.*, 1995; Keltner and Robinson, 1997); perceive greater polarization in the beliefs of others when they personally hold more extreme beliefs Van Boven *et al.* (2012); assume that supporters and opponents on either side of a conflict are balanced in size (Keltner and Robinson, 1997); and use their own beliefs as a heuristic to estimate the beliefs of others (Nickerson, 1999; Epley *et al.*, 2004). Having shown in this paper that the distribution of second-order climate beliefs are biased in ways that parallel this psychology scholarship, future research should examine the precise psychological mechanisms that shape second-order climate beliefmaking.

The result of this extant distribution of second-order climate beliefs is a reinforcement of existing political barriers to climate policy action. Geiger and Swim (2016) find that levels of climate conversation is a function of beliefs about the distribution of climate opinions; they find that individuals who under-estimate the distribution of beliefs self-silence for fear of social sanctions. Our findings would therefore suggest that the national publics in both the United States and China under-engage with the issue climate change relative to their true preference levels.

More broadly, when individuals hold beliefs about the general population that reinforce their personal views, this will lead them to "dig in" to their positions by believing that many more people agree with them than is actually the case. Simultaneously, systematic underestimation of the fraction of the

population holding pro-climate views may create obstacles to mobilization around the climate issue, since individuals don't believe that others share their support for policy action. By depressing levels of support for climate policy action, biases in second-order climate beliefs stand as an under-appreciated barrier to climate policy action. These beliefs are contributing to an erosion of any "community of fate" that Robert Keohane (2015, pg. 24) has argued is necessary to promote climate policy action. Conversely, shifting second-order climate beliefs can increase public support for collective climate actions. Our experimental evidence demonstrated that exposing individuals to the true distribution of Chinese climate beliefs made Americans more likely to support the 2014 US-China Climate Accord. These results underscore the neglected role of second-order climate beliefs in structuring mass climate opinions. Further efforts to specify the conditions under which biased second-order beliefs can be corrected provides a promising direction for future climate policy research.

These results also point to an indirect mechanisms through which economic losers from global warming may have succeeded in blocking climate policy action. An extensive literature has documented the role of carbon-intensive actors in casting doubt on the scientific consensus on climate change and disseminating climate misinformation (Oreskes and Conway, 2011; Brulle, 2014). These efforts directly undermine belief in climate change and beliefs about the scientific consensus, thus directly reducing political incentives for climate policy action. However, our results also suggest that they indirectly undermine support for action to the degree they also shape public estimates of the distribution of climate beliefs.

Further, it is noteworthy that, despite finding egocentric biases in the climate opinion estimates, we find evidence of common knowledge in the domain of rationales for climate beliefs. Differences in policy preferences did not translate into a differential tendency to believe that others would invoke one rationale over another for their position. These results thus emphasize the weakness of "information deficit" models of climate policy inaction, since the results suggest a broadly shared understanding of climate science and policy by both proponents and opponents. Differences in perceptions about the distribution of climate beliefs do not appear linked to mischaracterizations of the reasons that people agree or disagree about climate change. These results thus corroborate recent work that has emphasized the gap between public

understanding of climate science and stated individual beliefs in the findings of climate science (Kahan, 2015) or with active concern about climate risks (Kellstedt *et al.*, 2008; Norgaard, 2011). Public debates over climate have been ongoing for at least a decade, and the general public may be sufficiently exposed to different perspectives on the issue, even as they are unable or unwilling to adjust their individual beliefs and second-order beliefs accordingly.

Consequently, common knowledge in the domain of rationales may be a promising starting point for future research on collective climate action. If the public does have a shared understanding of the arguments underlying different climate belief positions, we can identify strategies to leverage this understanding into common support for policy action. Similarly, while recent research has focussed on increasing promoting knowledge about the existence of a scientific consensus on climate change (e.g. van der Linden *et al.*, 2014), efforts to facilitate greater awareness of the distribution of climate beliefs in the general public may also be a promising strategy to generate climate policy momentum.[17]

Given the enormous literature investigating the distribution of first-order climate beliefs and the central importance of second-order beliefs to the success of climate cooperation strategies, it remains surprising that we still know so little about the distribution of second-order beliefs. It is our hope that one contribution of this current paper will be to facilitate efforts by political science scholars to more systematically collect data on, and evaluate, these critical links between second-order beliefs and political support for climate reforms.

[17]Of course, climate polling could easily turn the public against taking action. This might especially be the case when costs are emphasized. Future research might explore how second order beliefs change as short term costs of taking action are emphasized.

References

Aklin, M. and Urpelainen, J. (2013a). Debating clean energy: Frames, counter frames, and audiences. *Global Environmental Change*, **23**(5), 1225–1232.

Aklin, M. and Urpelainen, J. (2013b). Political competition, path dependence, and the strategy of sustainable energy transitions. *American Journal of Political Science*, **57**(3), 643–658.

Aldrich, J. H., Sullivan, J. L., and Borgida, E. (1989). Foreign affairs and issue voting: Do presidential candidates 'waltz before a blind audience'. *American Political Science Review*, **83**(01), 123–141.

Barrett, S. (2006). Climate treaties and 'breakthrough' technologies. *The American Economic Review*, **96**(2), 22–25.

Bechtel, M. M. and Scheve, K. F. (2013). Mass support for global climate agreements depends on institutional design. *Proceedings of the National Academy of Sciences*, **110**(34), 13763–13768.

Berinsky, A. J., Huber, G. A., and Lenz, G. S. (2012). Evaluating online labor markets for experimental research: Amazon. com's mechanical turk. *Political Analysis*, **20**(3), 351–368.

Borick, C. P. and Rabe, B. G. (2010). A reason to believe: examining the factors that determine individual views on global warming. *Social Science Quarterly*, **91**(3), 777–800.

Boykoff, M. T. (2011). *Who speaks for the climate?: Making sense of media reporting on climate change*. Cambridge University Press, Cambridge, UK.

Boykoff, M. T. and Boykoff, J. M. (2004). Balance as bias: global warming and the us prestige press. *Global environmental change*, **14**(2), 125–136.

Brulle, R. J. (2014). Institutionalizing delay: foundation funding and the creation of us climate change counter-movement organizations. *Climatic Change*, **122**(4), 681–694.

Brulle, R. J., Carmichael, J., and Jenkins, J. C. (2012). Shifting public opinion on climate change: an empirical assessment of factors influencing concern over climate change in the us, 2002–2010. *Climatic change*, **114**(2), 169–188.

Buhrmester, M., Kwang, T., and Gosling, S. D. (2011). Amazon's mechanical turk a new source of inexpensive, yet high-quality, data? *Perspectives on Psychological Science*, **6**(1), 3–5.

Burgmann, V. and Baer, H. (2012). *Climate Politics and the Climate Movement in Australia*. Melbourne University Press, Melbourne, Australia.

Chambers, J. R. and De Dreu, C. K. (2014). Egocentrism drives misunderstanding in conflict and negotiation. *Journal of Experimental Social Psychology*, **51**, 15–26.

Chong, D. (1991). *Collective action and the civil rights movement*. University of Chicago Press, Chicago, IL.

Druckman, J. N. (2013). Public opinion: Stunted policy support. *Nature Climate Change*, **3**(7), 617–617.

Dryzek, J. S. (2013). *The politics of the earth: Environmental discourses*. Oxford University Press, Oxford.

Dunlap, R. E. and McCright, A. M. (2008). A widening gap: Republican and democratic views on climate change. *Environment: Science and Policy for Sustainable Development*, **50**(5), 26–35.

Egan, P. J. and Mullin, M. (2012). Turning personal experience into political attitudes: the effect of local weather on americans? perceptions about global warming. *The Journal of Politics*, **74**(03), 796–809.

Epley, N., Keysar, B., Van Boven, L., and Gilovich, T. (2004). Perspective taking as egocentric anchoring and adjustment. *Journal of personality and social psychology*, **87**(3), 327.

Erikson, R. S., Wright, G. C., and McIver, J. P. (1993). *Statehouse democracy: Public opinion and policy in the American states*. Cambridge University Press, Cambridge, UK.

Feldman, L., Maibach, E. W., Roser-Renouf, C., and Leiserowitz, A. (2012). Climate on cable: The nature and impact of global warming coverage on Fox News, CNN, and MSNBC. *The International Journal of Press/Politics*, **17**(1), 3–31.

Feygina, I., Jost, J. T., and Goldsmith, R. E. (2010). System justification, the denial of global warming, and the possibility of system-sanctioned change. *Personality and Social Psychology Bulletin*, **36**(3), 326–338.

Fielding, K. S., Head, B. W., Laffan, W., Western, M., and Hoegh-Guldberg, O. (2012). Australian politicians' beliefs about climate change: political partisanship and political ideology. *Environmental Politics*, **21**(5), 712–733.

Fischbacher, U., Gächter, S., and Fehr, E. (2001). Are people conditionally cooperative? evidence from a public goods experiment. *Economics Letters*, **71**(3), 397–404.

Frey, B. S. and Meier, S. (2004). Social comparisons and pro-social behavior: Testing" conditional cooperation" in a field experiment. *American Economic Review*, **94**(5), 1717–1722.

Gallup (2009). Public praises science; scientists fault public, media. `http://www.people-press.org/2009/07/09/public-praises-science-scientists-fault-public-media/` **Accessed: 2015-11-12**.

Geiger, N. and Swim, J. K. (2016). Climate of silence: Pluralistic ignorance as a barrier to climate change discussion. *Journal of Environmental Psychology*, **47**, 79–90.

Hamilton, C. (2007). *Scorcher: The dirty politics of climate change*. Black, Melbourne, Australia.

Hamilton, L. C. and Stampone, M. D. (2013). Blowin?in the wind: Short-term weather and belief in anthropogenic climate change. *Weather, Climate, and Society*, **5**(2), 112–119.

Hansen, J., Sato, M., and Ruedy, R. (2012). Perception of climate change. *Proceedings of the National Academy of Sciences*, **109**(37), E2415–E2423.

Healy, A. and Lenz, G. S. (2014). Substituting the end for the whole: Why voters respond primarily to the election-year economy. *American Journal of Political Science*, **58**(1), 31–47.

Herring, S. C., Hoerling, M. P., Peterson, T. C., and Stott, P. A. (2014). Explaining extreme events of 2013 from a climate perspective. *Bulletin of the American Meteorological Society*, **95**(9), S1–S104.

Hicks, R. and Tingley, D. (2011). Causal mediation analysis. *Stata Journal*, **11**, 609–615.

Howe, P. D. and Leiserowitz, A. (2013). Who remembers a hot summer or a cold winter? the asymmetric effect of beliefs about global warming on perceptions of local climate conditions in the us. *Global environmental change*, **23**(6), 1488–1500.

Howe, P. D., Mildenberger, M., Marlon, J. R., and Leiserowitz, A. (2015). Geographic variation in opinions on climate change at state and local scales in the usa. *Nature Climate Change*, **5**(6), 596–603.

Hughes, L. and Urpelainen, J. (2015). Interests, institutions, and climate policy: Explaining the choice of policy instruments for the energy sector. *Environmental Science & Policy*, **54**, 52–63.

Imai, K., Keele, L., Tingley, D., and Yamamoto, T. (2011). Unpacking the black box: Learning about causal mechanisms from experimental and observational studies. *American Political Science Review*, **105**, 765–789.

IPCC (2014). *Climate Change 2014: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Intergovernmental Panel on Climate Change, Geneva, Switzerland.

Iyengar, S. and Westwood, S. J. (2014). Fear and loathing across party lines: New evidence on group polarization. *American Journal of Political Science*, **59**(3), 690–707.

Javeline, D. (2014). The most important topic political scientists are not studying: adapting to climate change. *Perspectives on Politics*, **12**(02), 420–434.

Kahan, D. M. (2015). Climate science communication and the measurement problem. *Advances in Political Psychology*, **36**, 1–43.

Kellstedt, P. M., Zahran, S., and Vedlitz, A. (2008). Personal efficacy, the information environment, and attitudes toward global warming and climate change in the united states. *Risk Analysis*, **28**(1), 113–126.

Keltner, D. and Robinson, R. J. (1993). Imagined ideological differences in conflict escalation and resolution. *International Journal of Conflict Management*, **4**(3), 249–262.

Keltner, D. and Robinson, R. J. (1997). Defending the status quo: Power and bias in social conflict. *Personality and Social Psychology Bulletin*, **23**(10), 1066–1077.

Keohane, R. O. (2015). The global politics of climate change: Challenge for political science. *PS: Political Science & Politics*, **48**(01), 19–26.

Keohane, R. O. and Victor, D. G. (2011). The regime complex for climate change. *Perspectives on Politics*, **9**(01), 7–23.

Keohane, R. O. and Victor, D. G. (2016). Cooperation and discord in global climate policy. *Nature Climate Change*, **6**(6), 570–575.

Kertzer, J. D. and Brutger, R. (2015). Decomposing audience costs: Bringing the audience back into audience cost theory. *American Journal of Political Science*, **doi: 10.1111/ajps.12201**.

Kim, S. Y. and Wolinsky-Nahmias, Y. (2014). Cross-national public opinion on climate change: The effects of affluence and vulnerability. *Global Environmental Politics*, **14**(1), 79–106.

Kvaløy, B., Finseraas, H., and Listhaug, O. (2012). The publics' concern for global warming: A cross-national study of 47 countries. *Journal of Peace Research*, **49**(1), 11–22.

Lax, J. R. and Phillips, J. H. (2012). The democratic deficit in the states. *American Journal of Political Science*, **56**(1), 148–166.

Layzer, J. (2007). Deep freeze: How business has shaped the global warming debate in congress. In M. Kraft and S. Kamieniecki, editors, *Business and environmental policy: Corporate interests in the American political system*, pages 93–125. MIT Press, Cambridge, MA.

Layzer, J. A. (2012). *Open for Business: Conservatives' Opposition to Environmental Regulation*. MIT Press, Cambridge, MA.

Leiserowitz, A., Maibach, E., Roser-Renouf, C., Feinberg, G., and Howe, P. (2013). Americans' global warming beliefs and attitudes in april 2013. Technical report, Yale Project on Climate Change Communication, Yale University and George Mason University.

Leviston, Z., Walker, I., and Morwinski, S. (2013). Your opinion on climate change might not be as common as you think. *Nature Climate Change*, **3**(4), 334–337.

Malhotra, N. and Margalit, Y. (2010). Short-term communication effects or longstanding dispositions? the public?s response to the financial crisis of 2008. *The Journal of Politics*, **72**(03), 852–867.

Marks, G. and Miller, N. (1987). Ten years of research on the false-consensus effect: An empirical and theoretical review. *Psychological Bulletin*, **102**(1), 72.

Milkoreit, M. (2013). *Mindmade politics: The role of cognition in global climate change governance*. Ph.D. thesis, Ph. D. Thesis presented to the University of Waterloo in fulfillment of the thesis requirement for the degree of Doctor of Philosophy in Global Governance.

Milner, H. V. and Tingley, D. (2015). *Sailing the Water's Edge: The Domestic Politics of American Foreign Policy*. Princeton University Press, Princeton, NJ.

Mimno, D. and Lee, M. (2014). Low-dimensional embeddings for interpretable anchor-based topic inference. In *Proceedings of the 2014 Conference on Empirical Methods in Natural Language Processing (EMNLP)*, pages 1319–1328, Doha, Qatar. Association for Computational Linguistics.

Morris, S. and Shin, H. S. (2001). Global games: theory and applications. *Cowles Foundation for Research in Economics at Yale University, Discussion Paper No. 1275R*.

Nickerson, R. S. (1999). How we know and sometimes misjudge what others know: Imputing one's own knowledge to others. *Psychological bulletin*, **125**(6), 737.

Norgaard, K. M. (2011). *Living in denial: Climate change, emotions, and everyday life*. MIT Press, Cambridge, MA.

Oreskes, N. and Conway, E. M. (2011). *Merchants of doubt: How a handful of scientists obscured the truth on issues from tobacco smoke to global warming*. Bloomsbury Publishing USA, New York.

Ostrom, E. (2014). Collective action and the evolution of social norms. *Journal of Natural Resources Policy Research*, **6**(4), 235–252.

Pronin, E. (2007). Perception and misperception of bias in human judgment. *Trends in cognitive sciences*, **11**(1), 37–43.

Rabe, B. G. (2004). *Statehouse and Greenhouse: The Emerging Politics of American Climate Change Policy*. Brookings Institution Press, Washington, DC.

Roberts, M. E., Stewart, B. M., Tingley, D., Lucas, C., Leder-Luis, J., Gadarian, S. K., Albertson, B., and Rand, D. G. (2014). Structural topic models for open-ended survey responses. *American Journal of Political Science*, **58**, 1064–1082.

Robinson, R. J., Keltner, D., Ward, A., and Ross, L. (1995). Actual versus assumed differences in construal:" naive realism" in intergroup perception and conflict. *Journal of Personality and Social Psychology*, **68**(3), 404.

Ross, L., Greene, D., and House, P. (1977). The "false consensus effect": An egocentric bias in social perception and attribution processes. *Journal of Experimental Social Psychology*, **13**(3), 279–301.

Rubinstein, A. (1989). The electronic mail game: Strategic behavior under" almost common knowledge". *The American Economic Review*, pages 385–391.

Scruggs, L. and Benegal, S. (2012). Declining public concern about climate change: Can we blame the great recession? *Global Environmental Change*, **22**(2), 505–515.

Sterman, J. D. (2008). Risk communication on climate: mental models and mass balance. *Science*, **322**(5901), 532–533.

Sterman, J. D. (2011). Communicating climate change risks in a skeptical world. *Climatic Change*, **108**(4), 811–826.

Stern, N. (2007). *The Economics of Climate Change: The Stern Review*. Cambridge University Press, Cambridge, UK.

Stimson, J. A., MacKuen, M. B., and Erikson, R. S. (1995). Dynamic representation. *American Political Science Review*, **89**(03), 543–565.

Stokes, L. C. (2015). Electoral backlash against climate policy: A natural experiment on retrospective voting and local resistance to public policy. *American Journal of Political Science*, **doi: 10.1111/ajps.12220**.

Tausanovitch, C. and Warshaw, C. (2014). Representation in municipal government. *American Political Science Review*, **108**(03), 605–641.

Tingley, D. and Tomz, M. (2013). Conditional cooperation and climate change. *Comparative Political Studies*, **47**(3), 344–368.

Tranter, B. (2011). Political divisions over climate change and environmental issues in australia. *Environmental Politics*, **20**(1), 78–96.

Urpelainen, J. (2012). The strategic design of technology funds for climate cooperation: generating joint gains. *Environmental Science & Policy*, **15**(1), 92–105.

Uslaner, E. M. (2002). *The moral foundations of trust*. Cambridge University Press, Cambridge, UK.

Van Boven, L., Judd, C. M., and Sherman, D. K. (2012). Political polarization projection: Social projection of partisan attitude extremity and attitudinal processes. *Journal of personality and social psychology*, **103**(1), 84.

van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., and Maibach, E. W. (2014). How to communicate the scientific consensus on climate change: plain facts, pie charts or metaphors? *Climatic Change*, **126**(1-2), 255–262.

Ward, A. and Lee, R. (1997). Naive realism in everyday life: Implications for social conflict and misunderstanding. In A. Ward, L. Ross, E. Reed, E. Turiel, and T. Brown, editors, *Values and knowledge*, pages 103–135. Lawrence Erlbaum Association, Hillsdale, NJ.

Weber, E. U. and Stern, P. C. (2011). Public understanding of climate change in the united states. *American Psychologist*, **66**(4), 315.

Wood, B. D. and Vedlitz, A. (2007). Issue definition, information processing, and the politics of global warming. *American journal of political science*, **51**(3), 552–568.

Young, O. R. (2002). *The Institutional Dimensions of Environmental Change: Fit, Interplay, and Scale*. MIT Press, Cambridge, MA.

Zhao, X. (2009). Media use and global warming perceptions a snapshot of the reinforcing spirals. *Communication Research*, **36**(5), 698–723.

Online Supplemental Analyses

In this section, we present results from a series of secondary analyses on second-order climate beliefs conducted on our MTurk samples. First, we examine whether egocentric bias and global underestimation of the true levels of climate beliefs varies by by level of respondent education. We present evidence that it does not.

Second, we present data on US perceptions of the distribution of climate beliefs among US partisans. We find Democrats and most Republicans have relatively homogenous beliefs about the distribution of partisan climate preferences. The exception to this pattern are the minority of pro-climate Republicans. These individuals significantly overestimate the fraction of their Republican co-partisans who also believe in climate change and support climate policies.

Third, we present data on US perceptions of the distribution of climate beliefs in two additional countries beyond China: Canada and Japan. We find persistent egocentric bias in these results.

Perceptions of Second-Order Beliefs by Education Level.

We explore whether individual estimates of the distribution of climate beliefs varies across levels of education. We might expect that more highly educated individuals have more accurate beliefs about the global distribution of climate opinion and are less vulnerable to egocentric biases. Instead, we find that estimates of the distribution of second-order climate opinions do not strongly vary across education levels.

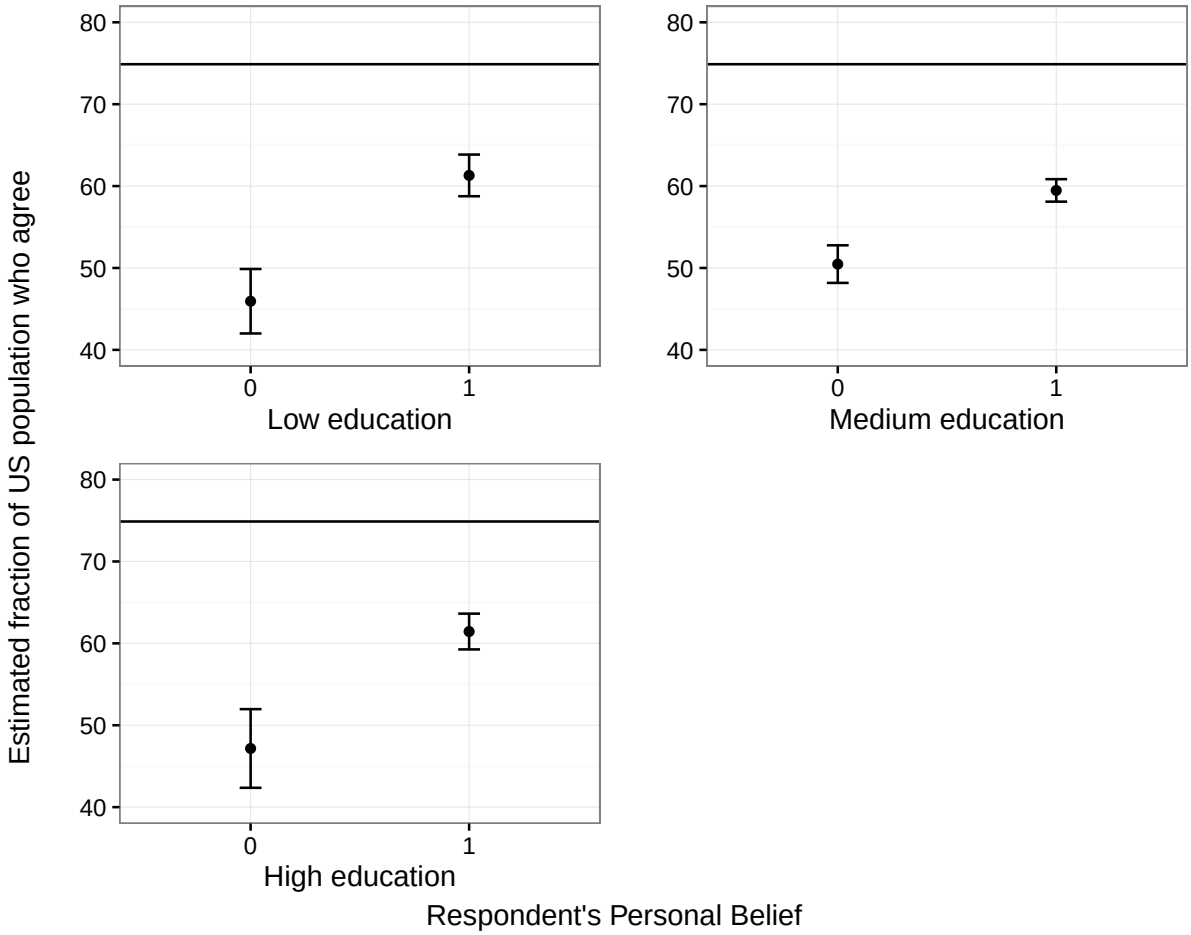

Figure 8: Estimates by US citizens of US population agreement with the statement "Global warming is happening," conditional on a respondent's reported personal beliefs. Respondents are split into three groups by level of education. The first pane provides estimates by respondents with a high school education or less. The second pane provides estimates for respondents with some college, technical school or a bachelor's degree. The third pane provides estimates for respondents with some graduate degree or more. The horizontal line on each graph gives the true population agreement with each statement (as estimated by March 2014 nationally representative SSI survey of the US population). Error bars give the 95% confidence interval.

Perceptions of Second-Order Beliefs among Partisans.

We explore whether individual estimates of the distribution of climate beliefs are similarly biased when considering the distribution of beliefs among out-groups. Perceptions of out-group beliefs are critical for models of climate policy action, since they condition the willingness of particular actors to trust the climate commitments of other actors. For instance, perceptions about the distribution of climate beliefs in other countries could shape international climate negotiations if they shape expectations about credibility

of other countries' climate commitments. In this section, we report the results of experimentally varying the political party of the reference population; in the next section, we report results from experimentally shifting the national identity of the reference population. Both analyses draw from our Mechanical Turk sample.

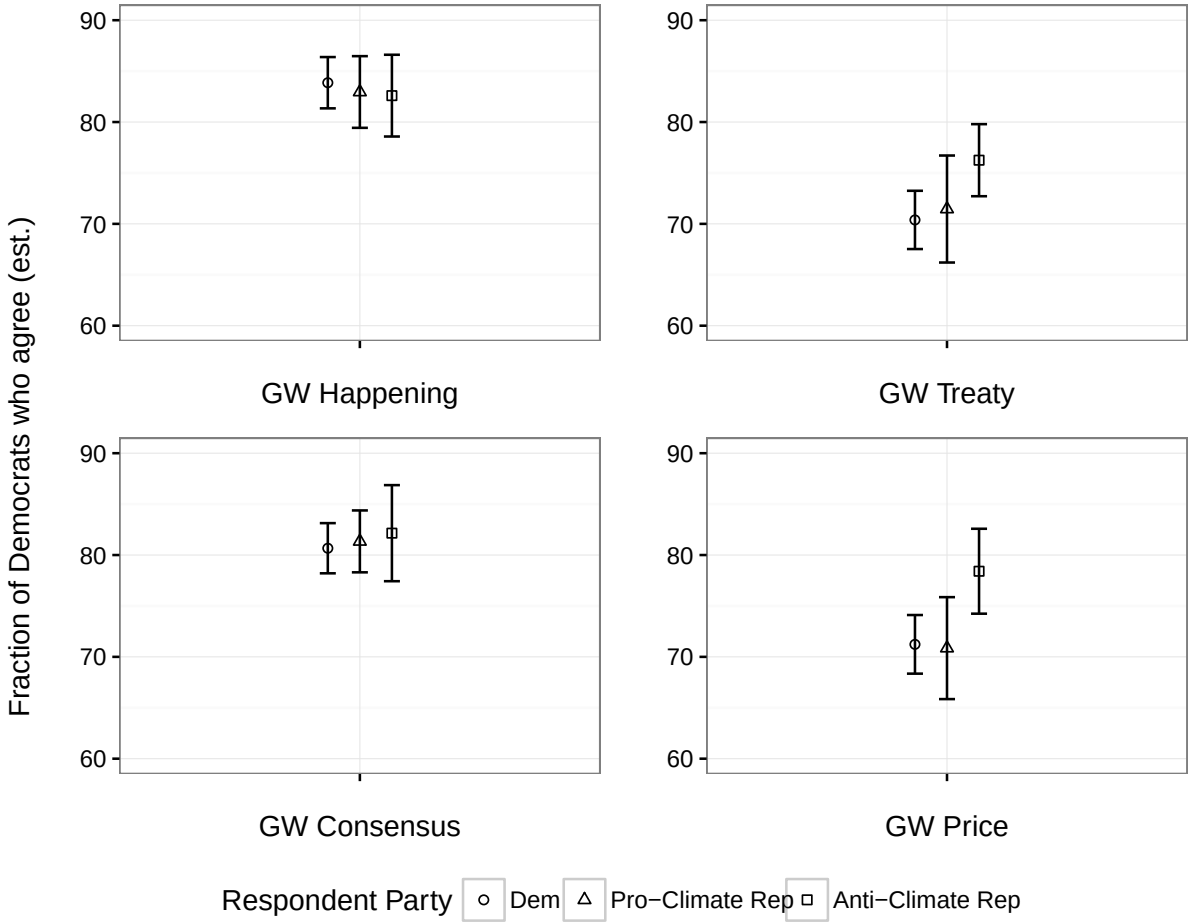

Figure 9: Estimated fraction of Democrats who agree with statements, by individual party type. *GW Happening* = "Global warming is happening." *GW Treaty* = "US should sign treaty requiring 90% cuts by 2050." *GW Consensus* = "Most scientists think global warming is caused by human activity." *GW Price* = "US should put price on pollution." Error bars give the 95% confidence interval.

First, we compare estimates of Democratic and Republican beliefs about climate change by Democratic and Republican partisans respectively. We differentiate between three partisan types: Democrats, Republicans who agree with a particular statement (pro-climate Republicans) and Republicans who dis-

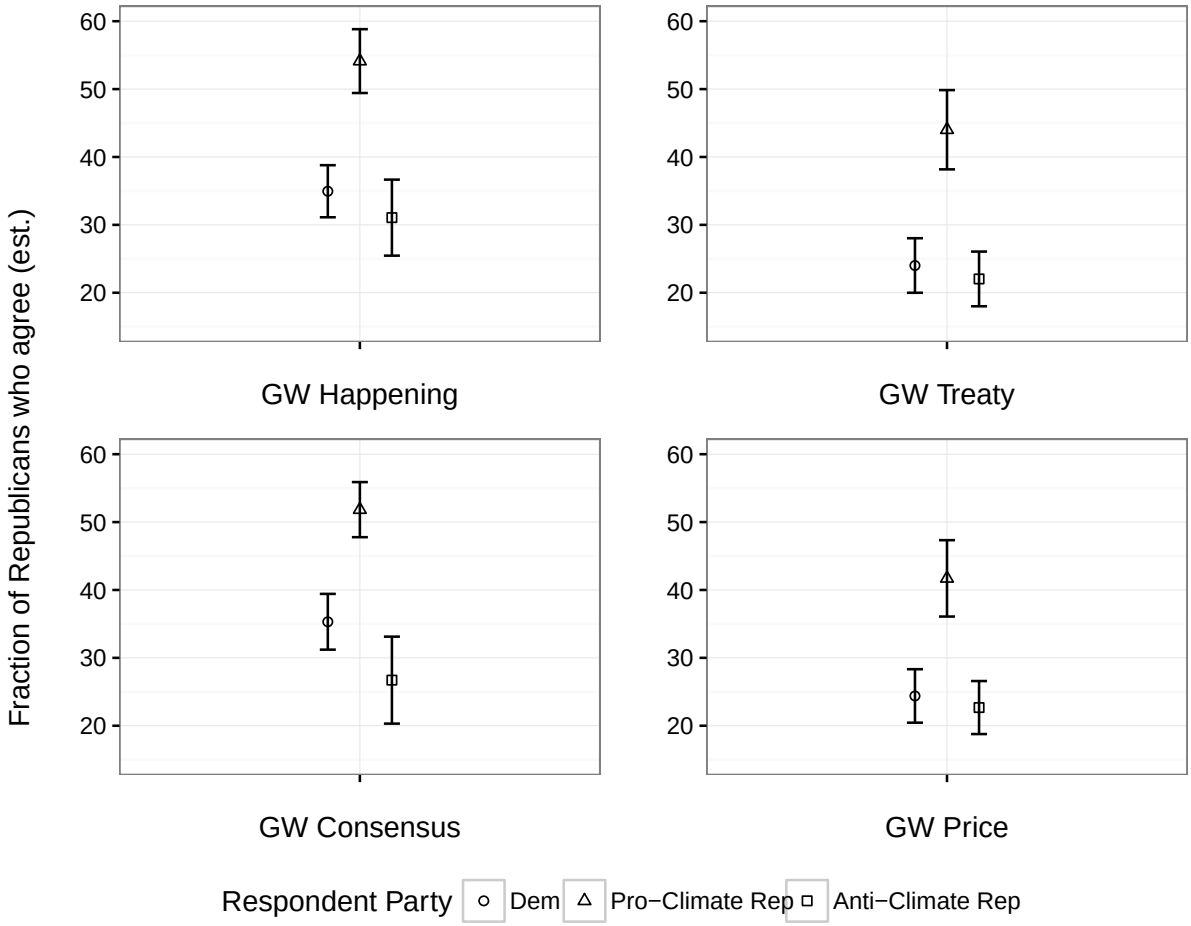

Figure 10: Estimated fraction of Republicans who agree with statements, by individual party type. *GW Happening* = "Global warming is happening." *GW Treaty* = "US should sign treaty requiring 90% cuts by 2050." *GW Consensus* = "Most scientists think global warming is caused by human activity." *GW Price* = "US should put price on pollution." Error bars give the 95% confidence interval.

agree with a particular statement (anti-climate Republicans). [18] In Figure 9, we summarize estimates of the fraction of Democrats who agree with the statements, conditional on the partisan type of the respondent. In Figure 10, we summarize estimates of the fraction of Republicans who agree with the statements, conditional on the partisan type of the respondent.

As shown in Figure 9, respondents of all partisan types systematically estimate Democrats to have high level of agreement with each statement. In contrast, as shown in Figure 10, Republicans are estimated to have lower levels of support. This is consistent with significant partisan polarization in this issue

[18] The number of Democrats in our sample who disagreed with any given statement were negligible and are dropped from this analysis.

domain. The public accurately perceives the existence of a major political cleavage between the two parties in the climate domain. More interestingly, when estimating the distribution of climate beliefs among Democrats, respondent partisan identity does not appear to condition estimates of partisan beliefs. Both Republicans and Democrats share a similar view of Democratic positioning on the climate issue. However, when estimating the distribution of climate beliefs among Republicans, respondent partisan identity does matter. As shown in Figure 10, while Democrats and Republicans who *disagree* with any particular statement provide similar estimates for the fraction of Republicans who agree with a given statement, the same is not true for "pro-climate" Republicans. Across all four climate statements, pro-climate Republicans systematically overestimate the fraction of their co-partisans who share their pro-climate views. This may be due to a desire for these Republicans, who are a minority within their party, to project greater in-group homogeneity than exists in reality, an example of the "false consensus" effect.

American perceptions of the distribution of climate beliefs among additional foreign publics

In Figure 11, we expand the analysis presented as Figure 3 to summarize the US public's estimates of the distribution of climate beliefs in Canada and Japan, two countries that are arguably perceived by many US citizens as reasonably similar to the United States. This data draws from our MTurk sample. We find persistent egocentric bias in estimates of the distribution of climate beliefs among the Canadian and Japanese publics. Further, while the US public estimates that levels of climate beliefs are similar to the United States in both countries, all individuals no matter their personal beliefs appear to believe that foreign populations have wider support for the US acting on climate change than the US population does. At the same time, US citizens perceive that levels of more factual climate beliefs are broadly similar in other countries to the beliefs they ascribe to the US population.

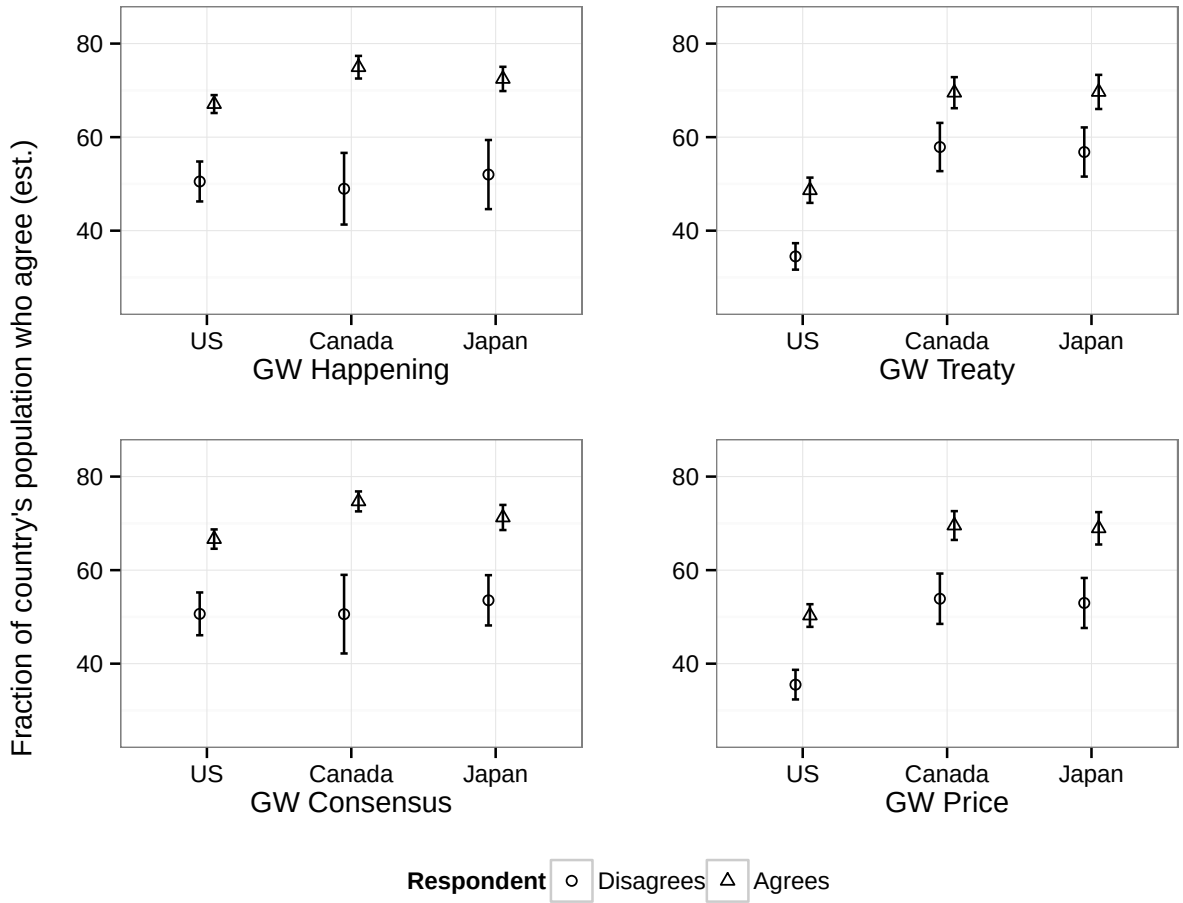

Figure 11: Estimates by US citizens of US, Canadian and Japanese population agreement with statements, conditional on respondent's personal beliefs. *GW Happening* = "Global warming is happening." *GW Treaty* = "US should sign treaty requiring 90% cuts by 2050." *GW Consensus* = "Most scientists think global warming is caused by human activity." *GW Price* = "US should put price on pollution." Error bars give the 95% confidence interval.

The content of climate beliefs imputed to political actors

Figure 12 presents the results for a political actors prompt. This prompt asked respondents to suggest the rationales that a politician might have for believing or disbelieving in climate change. Specifically, we asked: "Some politicians in the United States believe that climate change is not due to human activity. Other politicians think that humans are causing the planet's climate to change. We would like for you to imagine you are talking to a member of Congress who does [does not] believe that humans are changing the climate. Imagine you asked each him or her why they believe humans are [are not] causing climate

change. What do you think they would tell you? Please write several sentences, focusing on what you think their responses would be. They would say..."

The format of the figure is the same as in Figure 7. The top left plots words highly exclusive to reach topic and the top right plots the differences between those asked to write about a politician arguing that humans do and those arguing that humans do not cause climate change. Topics 5 and 7 reflect the main themes for politicians who do not believe that humans are causing climate change. Both lean on natural changes in the climate, with topic 7 emphasizing insufficiency in scientific proof about the matter much more than topic 5. Topic 1 picks up on the physical mechanisms linking human behavior and climate change (e.g., carbon dioxide changes) whereas topic 8 focuses on behaviors that generate these mechanisms (e.g., humans driving cars). The bottom left and bottom right plot differences, for each condition, between individuals in our survey that belief, or do not belief, climate change is happening.

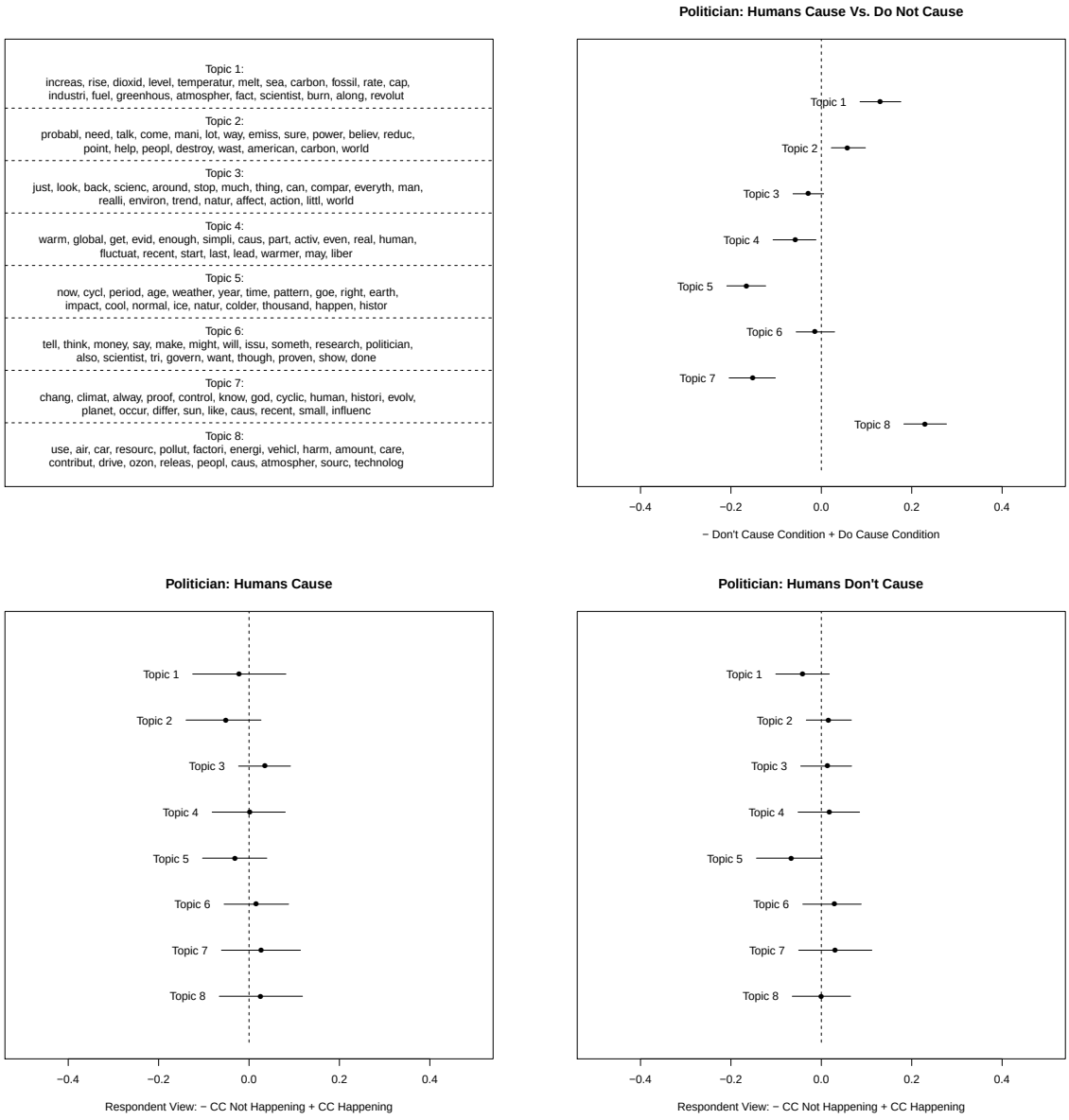

Figure 12: Top left of figure lists words highly exclusive to each topic. Top right gives the topic contrast between those in the climate change not happening versus happening conditions. Bottom half of figure plots the relationship between topics and respondent's own views on whether climate change is happening. The left hand plot is for people who were asked to write about a politician who thinks humans are causing climate change, and the right plot for people who were asked to imagine a politician who does not think humans are causing climate change. The lines in the plot represent 95% confidence intervals for the *difference* between respondents who themselves think climate change is versus is not happening. Effects that are further to the left are more likely to be mentioned by an individual who does not believe climate change is happening. Effects that are further to the right more likely to be mentioned by an individual who does believe climate change is happening.