

Beliefs about Climate Beliefs: Second-Order Opinions in the Climate Domain¹

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Abstract

Existing work on public opinion about climate opinion predominantly focuses on average levels of support for different climate related questions, and what explains variation in this support. However, we know very little about ‘second-order’ climate opinions: individual beliefs about the climate beliefs of others. This article unpacks the distribution and content of these second-order climate opinions among the US public. We find that the general public underestimates population-level belief in climate change, believing that the public is more divided over the existence of climate change than is true in reality. Further, individual perceptions of the climate beliefs of others are egocentrically biased, with climate change disbelievers reporting systematically lower estimates of the distribution of population-level climate beliefs. We also find significant biases in second-order climate beliefs as we experimentally vary, first, the partisan affiliation and, second, the national identity of a reference population. We also confirm a similar bias in a nationally representative survey of the Chinese public. However, we do not find significant differences in the rationales that Americans attribute to others, regardless of their personal climate beliefs. We conjecture how our results speak to prospects for collective action on climate change.

1 Introduction

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 in 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 response to climate change has prompted extensive investigation of climate attitudes and policy preferences amongst global publics. Public belief in climate change is highly variable across countries (Kvaløy *et al.*, 2012; Kim and Wolinsky-Nahmias, 2014), and public concern about climate change is substantially lower than the level of concern among climate scientists and policy experts (Leiserowitz *et al.*, 2013). In the United States, public concern about the climate threat has declined significantly over the past several years, even as the threat of climate change has become more serious and well-understood.

An emerging literature seeks to explain the disconnect between serious climate risks and uneven concern about climate change by emphasizing 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 complex time delays (Stermann, 2008, 2011). Scholars have also explored how public beliefs about climate change respond to a range of social and psychological cues, rather than changes in knowledge about climate science. They have variously described how climate attitudes are a function of elite political cues (Krosnick and MacInnis, 2012; Borick and Rabe, 2010; Brulle *et al.*, 2012; Mildemberger and Leiserowitz, 2014), media content (Boykoff and Boykoff, 2004; Zhao, 2009; Feldman *et al.*, 2011; Boykoff, 2011), emotional self-regulation (Norgaard, 2011; Milkoreit, 2013), cognitive biases (Feygina *et al.*, 2010), or cultural world views (Dryzek, 2013; Kahan,

2014).

These studies emphasize the interpersonal nature of climate cognition. Individual climate beliefs are shaped by communication with peers or by communications from elites. Correspondingly, there has been extensive scholarship exploring how different climate-related communications shape individual-level climate beliefs and policy preferences. Descriptively, there has also been extensive scholarship and polling on the distribution of climate beliefs within a wide range of different target populations. 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. While climate opinion scholars have extensively investigated the distribution of individual beliefs about climate change, we still know very little about ‘climate common knowledge’ and associated second-order climate beliefs: individual beliefs about the climate beliefs of others. This paper begins to address this gap, detailing a missing link in the existing climate opinion literature. We investigate the distribution of beliefs about the beliefs of others in the climate policy domain using original data from both the United States and China.

We believe these beliefs are fundamentally important in part because of their potential connection to decisions to take part in collective action.¹ Collective action accounts of the climate crisis emphasize that no actor has a unilateral incentive to abate their carbon pollution. By reducing individual carbon consumption, an actor voluntarily imposes concentrated costs on themselves while receiving only a fraction of the globally-distributed benefits associated with their actions (Sandler, 2004; Stern, 2007). Without cooperation, every actor has the incentive to free-ride off the actions of others, and no climate policy action will emerge. However, climate cooperation will turn in part on beliefs about the beliefs of others. In the simplest case, climate cooperation depends on individuals trusting that other actors will respond reciprocally to policy actions to avoid the risk of costly unilateral action. If individuals believe that many others do not believe humans are causing climate change, for example, then this might be undermined.

¹For example, this point is made in Chong (1991); Uslander (2002); Ostrom (2014).

The structure of the paper is as follows. Section 2 briefly discusses the existing theoretical and empirical literature on second order beliefs. Section 3 introduces our survey designs and Section 4 presents our results. Section 5 concludes the discussion.

2 Beliefs about the Climate Beliefs of Others

How individuals make inferences about the states of mind of others has been a major topic in cognitive psychology for decades. Debate has centred on whether individuals make sense of the actions of others through simulation of their state of mind or by unconscious theorizing using folk psychological beliefs (Gordon, 1992). In recent years, the *simulation* view has grown more popular, as psychologists argue that individuals make inferences about the state of mind of others by imagining themselves *as* other people (Lillard, 1998; Gordon, 1992)

In the simplest *simulation* models, individuals use their own beliefs as a heuristic to impute the beliefs of others (Nickerson, 1999; Epley *et al.*, 2004). Because individuals will have some intuitive sense that other people are different than themselves, they will often modify this imputation as a function of perceived differences between themselves and the imputed population. For example, Nickerson (1999) suggests that individuals discount the ability of others to access personal knowledge they link to their own expertise. However, referencing the anchoring and adjustment heuristic (cf. Tversky and Kahnemann 1974), he argues that most individuals insufficiently adjust when imputing the beliefs of others. The result is that many individuals systematically over-represent the incidence of similar beliefs to their own and underestimate the incidence of contrasting beliefs. Epley and Gilovich (2006) link this underadjustment to a satisficing dynamic: individuals stop their efforts to impute the beliefs of others once they reach a plausible belief that is closest to their own beliefs, rather than searching for the likely belief of another person. A resulting tendency to underestimate group disagreement is also reflected in the literature on the “false consensus effect”, which documents how individuals overestimate the homogeneity of group beliefs (Ross *et al.*, 1977; Marks and Miller, 1987).

A related literature has focussed on perspective-taking, the ability of individuals to

put themselves in the minds of others and accurately infer their mental state. Explicitly asking people to take-on the perspective of another person in turn shapes individual attitudes (Epley and Gilovich, 2006). This has emerged as a significant concern in various lab and survey experiments that ask individuals to imagine themselves as some external actor (Kertzer and Renshon, 2014). Models of perspective-taking, like models of how individuals make judgements about the beliefs of others, emphasize the ways in which individual imputations of the belief states of others are conditioned by their own beliefs.

The overall finding of these literatures is that there is a general *egocentric bias* in the way that individuals make judgements about the beliefs of others, particular the beliefs of people who they perceive as similar. An immediate implication of this perspective is that individual perceptions about the distribution of beliefs among various out-groups - for instance members of a different political party or the citizens of a foreign country - may be less subject to egocentric biases than estimates of the distribution of beliefs among a respondent's in-group.

Additionally, the existence of egocentric bias emphasizes the importance of understanding the social practices that might reinforce or disrupt biased perceptions about the distribution of group beliefs. Generally political scientists find evidence that individuals prefer to communicate and politically interact with individuals that share their beliefs, values and identities. For instance, the US public prefers to communicate with co-partisans (Broockman and Ryan, 2014), prefers to consume media that reinforces their ideological predispositions (Stroud, 2011), and discounts politically-relevant information that contradicts existing attitudinal commitments (Taber and Lodge, 2006). Asymmetric communication patterns of this sort will tend to reinforce egocentric second-order beliefs by (incorrectly) validating respondent perceptions that their views are widely shared by the population at large.

The dynamics of second-order climate opinions are critical to an understanding of climate politics. A handful of studies have documented how individuals systematically underestimate the fraction of the US population who believe in climate change (e.g. 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 overestimate the true population level that believes in climate. 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.

Furthermore, we and others argue understanding second order beliefs is crucial for understand the conditions under which collective climate action is possible. This reflects a more general point that beliefs about the beliefs of others is crucial for collective action Chong (1991); Uslander (2002); Ostrom (2014). For example, if individuals underestimate the extent to which others think climate change is happening, then this could reduce the probability of personally engaging as one would not suspect many others will also contribute.²

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,³ and across different reference populations. Further, existing research has exclusively measured second-order climate opinions by asking respondents to numerically estimate population-level agreement or disagreement with particular beliefs. It is equally important to understand the content of imputed climate beliefs, particularly the complex rationales that individuals construct to make sense of the beliefs of others.

²In separate and ongoing work we directly test this proposition.

³Both Leviston *et al.* (2013) and (Fielding *et al.*, 2012) were conducted in Australia. Climate change is exceptionally politicized in Australia, the result of intensive public conflict over climate policy over 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 also important to ensure their basic results replicate in samples of the US public.

3 Research Design and Predictions

3.1 Survey Design

To explore second order climate beliefs in the United States, we fielded two surveys on samples of the US public. First, we conducted a nationally-representative survey in March 2014 using a sample from Survey Sampling International (n=1815). On this survey, we asked respondents to estimate the fraction of the US population that agreed with a series of statements about climate change. Separately on this survey, we also collected individual-level beliefs about these statements for all respondents. Finally, we asked respondents their willingness to communicate about climate change with a variety of other actors.

Second, we fielded several followup surveys during the summer of 2014 using Amazon’s Mechanical Turk service. These surveys asked respondents to estimate the climate beliefs of others, but randomly varied the national identity or political affiliation of the reference populations. These surveys also asked respondents to explain the rationales that selected individuals might have for holding various climate beliefs, using open-ended text questions. These open-ended questions are described in more detail in Section 4.5.

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 was collected by the authors in previous work. This database included responses to previous questions about respondents’ climate change opinions.⁴ 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 in human-caused climate change and 1002 had

⁴In 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?”

previously indicated they did not believe in human-caused climate change. We received 1131 complete surveys, a response rate of 56.5%. While our resulting sample is not perfectly balanced on belief in climate change, this procedure gave decidedly better balance on individual-level climate beliefs than would be the case if we had relied on an opt-in sample from the general Mechanical Turk population. All respondents were required to be from the United States and have over a 95% approval rating from previous Mechanical Turk tasks.

Finally, we conducted a survey in February of 2015 in China using the firm Survey Sampling International. This survey used quota sampling to achieve an approximately nationally representative sample based on gender, age, and region.

3.2 Questions and Predictions

First, we explored how individual respondent beliefs shapes estimates of population-level climate beliefs. We presented each respondent with a series of 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. 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).” We predicted that estimates of population-level beliefs would be conditioned by individual-level respondent beliefs. For instance, we expected that individuals who did *not* agree with a given statement would report lower overall estimates of population agreement with that statement.

Second, we explored how estimates of population-level climate beliefs shift when changing the reference population. Individuals may well condition their beliefs about the distribution of climate beliefs in the United States according to their personal beliefs; however, how do individuals impute the beliefs of various out-groups, including members of different political parties or citizens of foreign countries? For these questions we used an expanded series of statements that included beliefs about climate change *and* climate policy preferences. These four statements were: 1) Global warming is happening; 2)

Global warming is caused by human activity; 3) The United States should pass a policy to increase the cost of carbon pollution; and 4) The United States should sign an international treaty that requires the US 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 U.S. population would AGREE with the statement that [statement] Type a number from 0 (no one) to 100 (everyone).”

In one set of conditions, we randomly assigned different countries to be the reference population. Respondents were either asked to estimate the fraction of the US population, the fraction of the Canadian population, the fraction of the Japanese population or the fraction of the Chinese population who agreed with a particular statement. The objective was to explore whether US citizens perceive the citizens of other countries as having systematically different beliefs about climate change than themselves. We also predicted that individual respondent beliefs would more significantly condition estimates of similar countries than dissimilar countries. This is because US responders would be more comfortable using their own opinions to impute foreign populations who they perceived as more similar to themselves. For example, we expected that estimates of Chinese climate beliefs would be *least* sensitive to the individual beliefs of survey respondents.

In a second set of conditions, we randomly assigned different partisan groups to be the reference population. Respondents were either asked to estimate the fraction of US Democrats or US Republicans who agreed with a particular statement. We predicted that individuals would more strongly anchor their estimates to their own beliefs when imputing the beliefs of co-partisans, again because they would more closely identify with this reference subpopulation.

Third, we also explored the discursive willingness of individuals to communicate with individuals holding a variety of different beliefs about climate change. Here, we followed a question construction from Leiserowitz *et al.* (2013). If, as we predict, perceptions of others’ beliefs are shaped by individual beliefs, then it is also important to understand the social contexts under which respondents might be exposed to new information about the climate beliefs of others. Exchanges of this type could provide an important information

signal to shape the global distribution of second-order climate beliefs.

Finally, we investigate what individuals think the rationales are of people who hold specific views on climate change. That is, we let individuals express the reasoning that they think others would give if asked to explain their position. Hence, while the above questions taps beliefs about the distribution of beliefs, we also address beliefs about the rationales others will bring to the table.

In summary, we draw on new data to answer the following questions.

- What is the distribution of opinion about science and policy related climate opinions?
- What is the *perceived* distribution of beliefs about science and policy related climate opinions, and how does an individual's beliefs shape perceptions about the distribution of population beliefs?
- How do responses to the previous question change as the reference population changes?
- Are second-order climate beliefs structured similarly across different countries?
- Who is more comfortable talking to others, including people that disagree with them, about climate change?
- What rationales do individuals attribute to the beliefs of others? Are these attributed rationales conditional on an individual's personal beliefs about climate change?

4 Survey Results

4.1 Estimating the Beliefs of Others

First, we report respondent estimates of the fraction of the US population who agrees or disagrees with a series of statements about climate change. These estimates draw from the

nationally representative SSI survey fielded in March 2014. Figure 1 summarizes average estimates of the fraction of the US population who agrees or disagrees with a particular statement. We find that the US public underestimates the true level of pro-climate beliefs for all three statements. Further, we find that individuals condition their second order climate beliefs on their individual agreement or disagreement with a particular statement. For all three statements, respondents who individually disagree with a statement report systematically lower estimates of population agreement with that statement. These results replicate findings from Leviston *et al.* (2013) for the first time in a US context. Across a range of different climate beliefs and climate policy preferences, the US public shows egocentric bias in their estimates of the distribution of climate opinions.

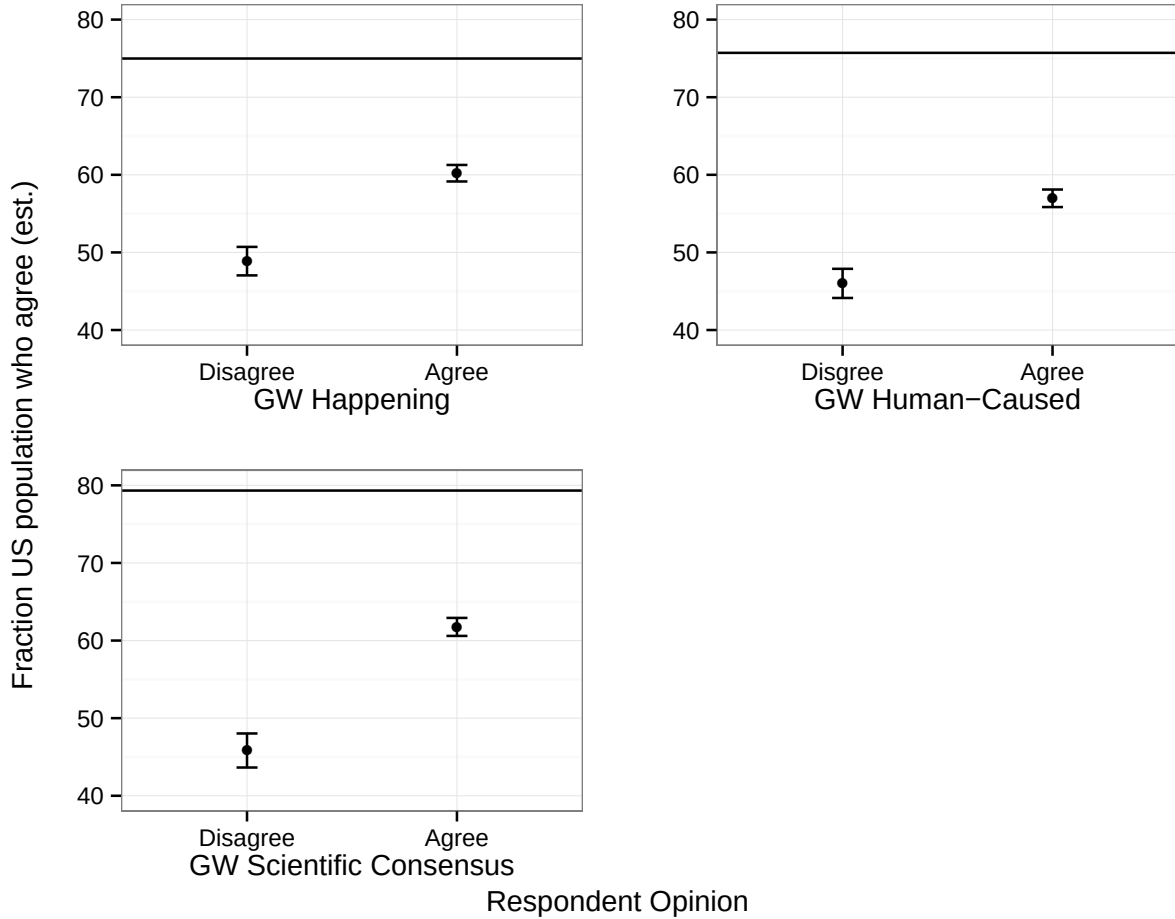


Figure 1: Estimates of population-level climate beliefs conditional on respondent beliefs. *GW Happening* = “Global warming is happening.” *GW Human-Caused* = “Global warming is caused by human-activity.” *GW Consensus* = “Most scientists think global warming is caused by human activity.” The horizontal line on each graph gives the true national level of agreement with these statements (as estimated by the March 2014 nationally representative SSI survey). Error bars give the 95% confidence interval.

4.2 Experimentally Manipulating the Reference Population

Next, 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 manipulating the national identity of the reference population. Both analyses draw from our Mechanical Turk sample.

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 disagree with a particular statement (anti-climate Republicans).⁵ In Figure 2, we summarize estimates of the fraction of Democrats who agree with the statements, conditional on the partisan type of the respondent. In Figure 3, 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 2, respondents of all partisan types systematically estimate Democrats to have high level of agreement with each statement. In contrast, as shown in Figure 3, Republicans are estimated to have lower levels of support. This is consistent with significant partisan polarization in this issue 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 3, 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

⁵The number of Democrats in our sample who disagreed with any given statement were negligible and are dropped from this analysis.

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.

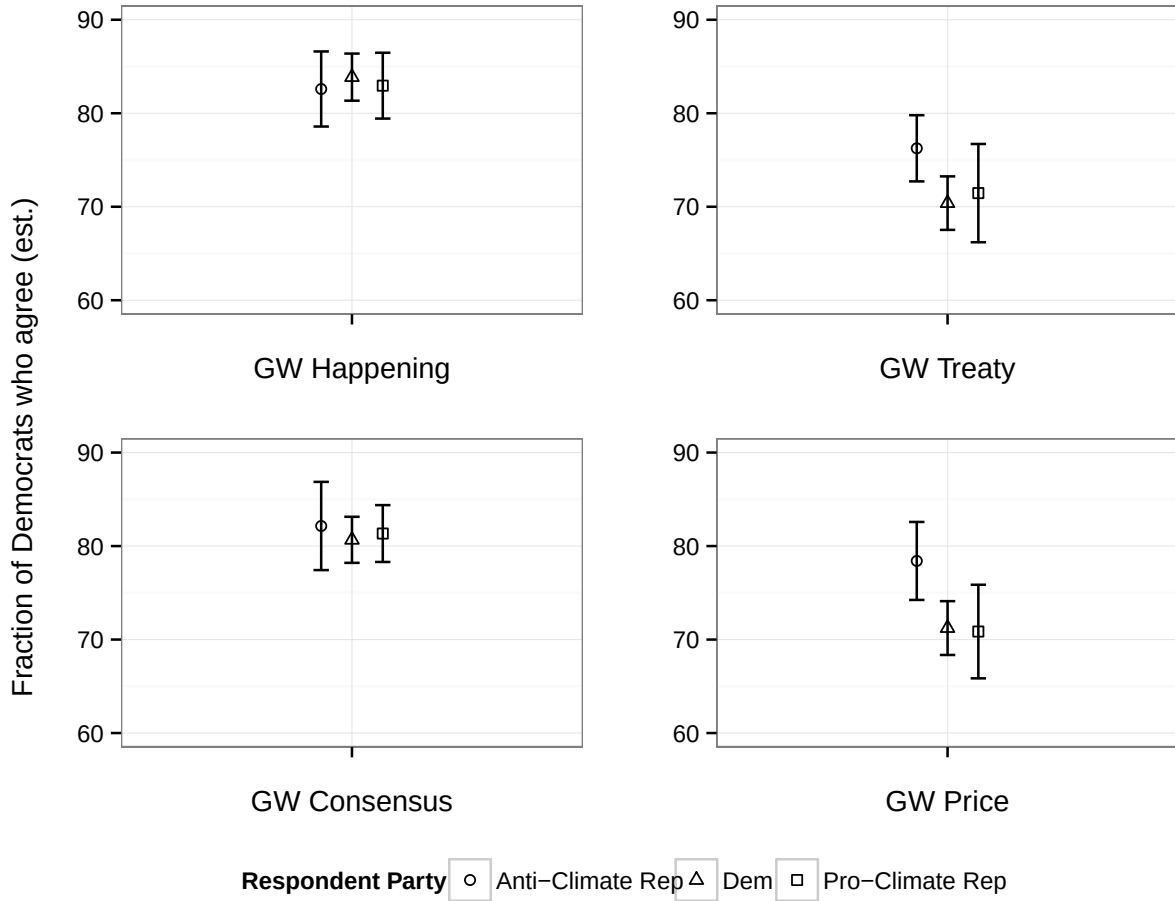


Figure 2: Estimated fraction of Democrats who agree with statements, by individual party type. *GW Happening* = “Global warming is happening.” *GW Treaty* = “US should sign treaty requiring 90% cuts by 2050.” *GW Consensus* = “Most scientists think global warming is caused by human activity.” *GW Price* = “US should put price on pollution.” Error bars give the 95% confidence interval.

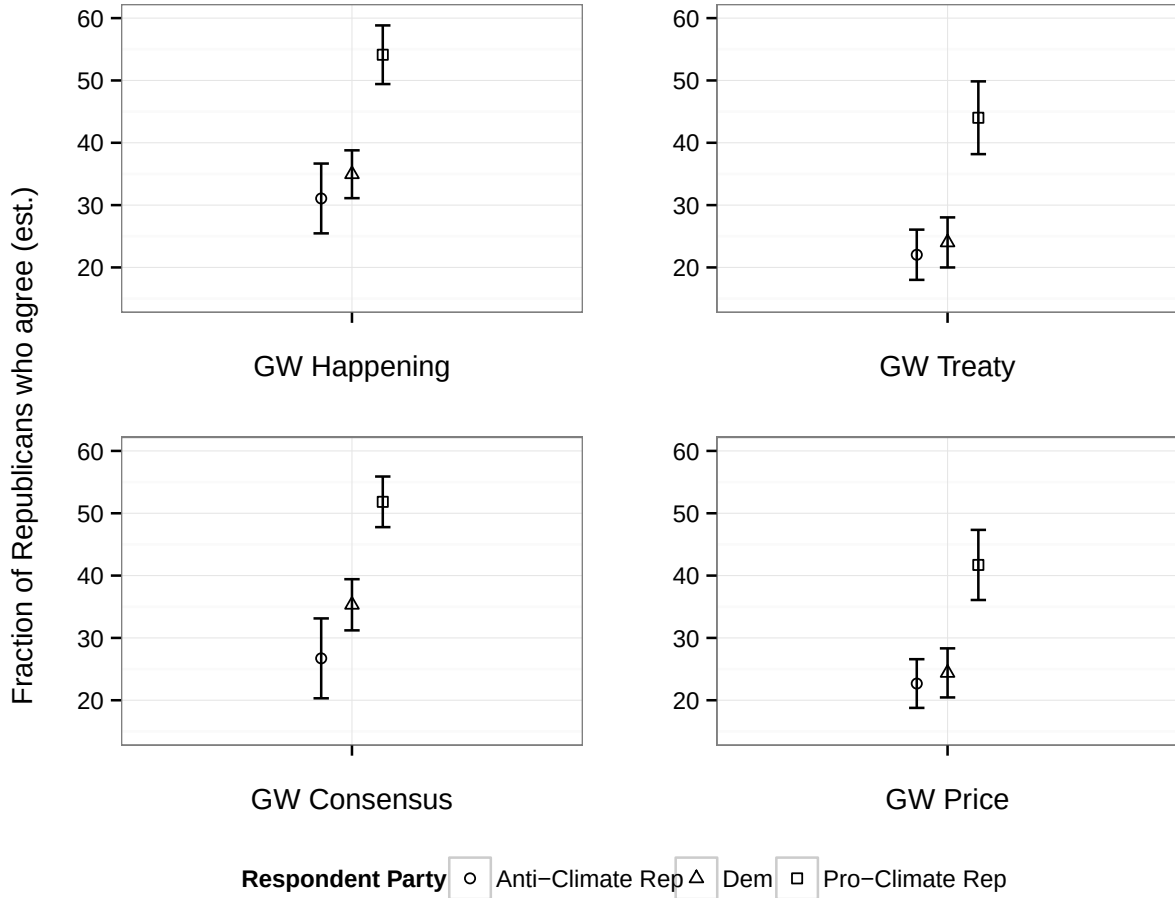


Figure 3: Estimated fraction of Republicans who agree with statements, by individual party type. *GW Happening* = “Global warming is happening.” *GW Treaty* = “US should sign treaty requiring 90% cuts by 2050.” *GW Consensus* = “Most scientists think global warming is caused by human activity.” *GW Price* = “US should put price on pollution.” Error bars give the 95% confidence interval.

Second, we evaluate how the US public estimates the distribution of climate beliefs in a range of foreign countries. This is an alternative way to modulate the outgroup rather than using partisan affiliation above. Figure 4 provides the average estimates of the population agreement with four climate statements in the United State and China. As predicted, we do find evidence that individuals condition their estimates on the basis of their individual beliefs *less* when estimating the distribution of climate beliefs in China,

as compared to estimating the distribution of climate beliefs in the United States. This attenuation of egocentric bias is statistically significant for the two climate policy-related statements (Price and Treaty) but only a non-significant tendency for the the two climate belief statements (Happening and Consensus).⁶

In Figure 5, we expand this analysis to consider US estimates to 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. In contrast to the case of China, we see persistent egocentric bias in estimates of the distribution of climate beliefs among the Canadian and Japanese publics. 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 impute to the US population.

⁶We had a subset of respondents fill out a cosmopolitanism scale (Cleveland *et al.*, 2014). As one would predict, anti-climate respondents scored lower on the cosmopolitan scale (consistent with having more conservative worldviews). We might expect that individuals who score higher on a cosmopolitanism scale perceive themselves as more similar to individuals in foreign countries. These individuals might then show increased egocentric bias when estimating Chinese or Japanese climate population beliefs. We do not find any evidence for such egocentric bias conditional on cosmopolitanism score.

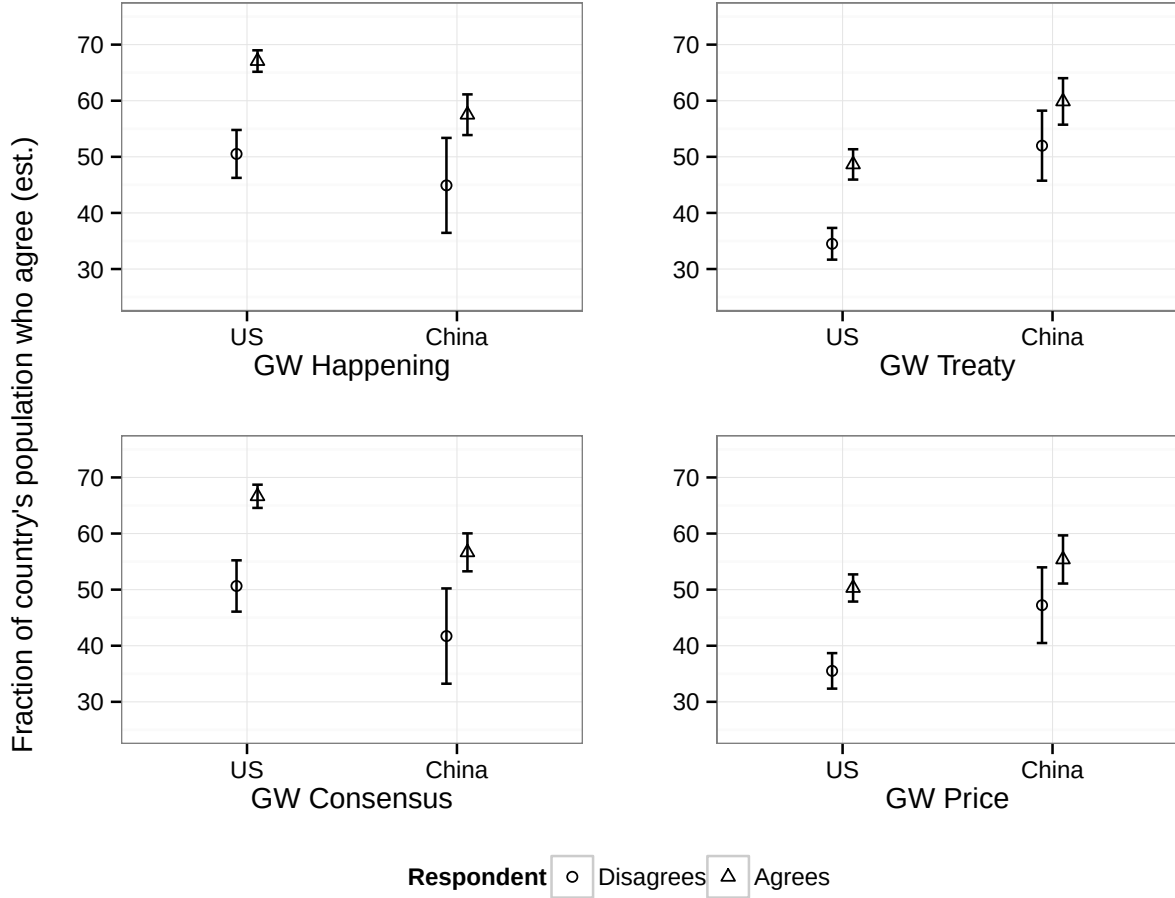


Figure 4: Estimated US and Chinese population agreement with statements, conditional on individual belief type. *GW Happening* = “Global warming is happening.” *GW Treaty* = “US should sign treaty requiring 90% cuts by 2050.” *GW Consensus* = “Most scientists think global warming is caused by human activity.” *GW Price* = “US should put price on pollution.” Error bars give the 95% confidence interval.

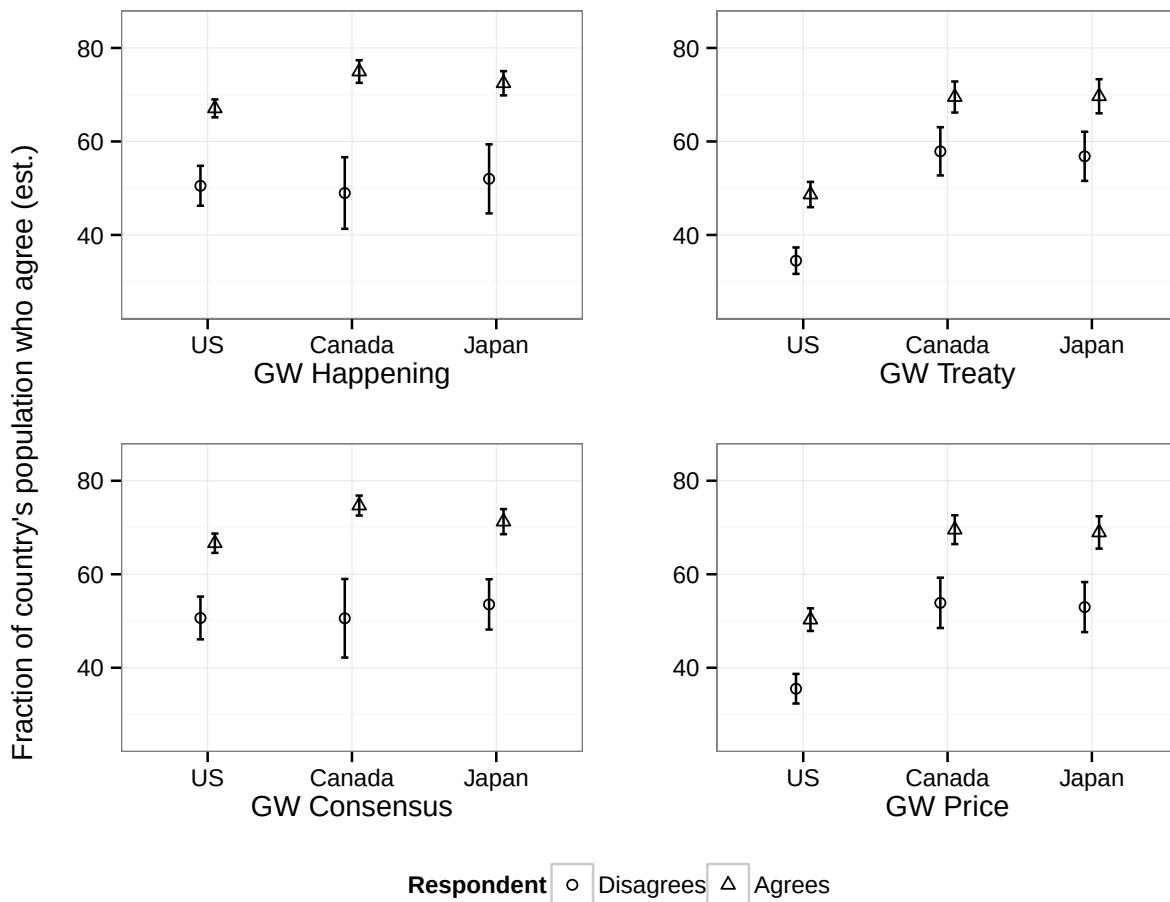


Figure 5: Estimated US, Canadian and Japanese population agreement with statements, conditional on individual belief type. *GW Happening* = “Global warming is happening.” *GW Treaty* = “US should sign treaty requiring 90% cuts by 2050.” *GW Consensus* = “Most scientists think global warming is caused by human activity.” *GW Price* = “US should put price on pollution.” Error bars give the 95% confidence interval.

4.3 Extending to a Chinese Sample

Finally, we deepen our exploration of second-order climate beliefs by asking *Chinese* citizens about their second-order perceptions of US and Chinese climate beliefs. This analysis thus replicates the analysis in Figure 4, but changes the survey respondent population to a nationally representative sample of 1650 Chinese citizens, conducted in February 2015 by the survey firm Survey Sampling International.

In Figure 6, we show Chinese second-order beliefs about US and Chinese science beliefs in the left column. Note that since the baseline level of belief that global warming is happening in China is high, the sample who disagrees with this statement is small, resulting in the large sampling errors for this population.⁷ We focus first on Chinese beliefs about the beliefs of other Chinese citizens which is presented in the left column. We find that individuals who believe global warming is happening and who think most scientists think global warming is happening estimate that a larger fraction of the total Chinese population shares their perspective. This is in contrast to those who disagree with these statements, who put the average levels much lower. However, exactly as in the United States, Chinese citizens systematically underestimate the true fraction of the Chinese population who holds these varied climate beliefs.

Turning to Chinese estimates of US beliefs, presented in the right column of Figure 6 we see evidence of the same egocentric bias as presented earlier. 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 scientists.

In Figure 7, we present second-order beliefs about US and Chinese *policy* preferences. Again, we see evidence of egocentric bias. For example, individuals who oppose a treaty estimated the percentage of others supporting a treaty to be around 25%. Individuals supporting a treaty estimated this to be approximately 55%. Interestingly, when we look

⁷We obtain similar results if we compare individuals who somewhat agree versus those who completely agree, which also yields tighter confidence intervals.

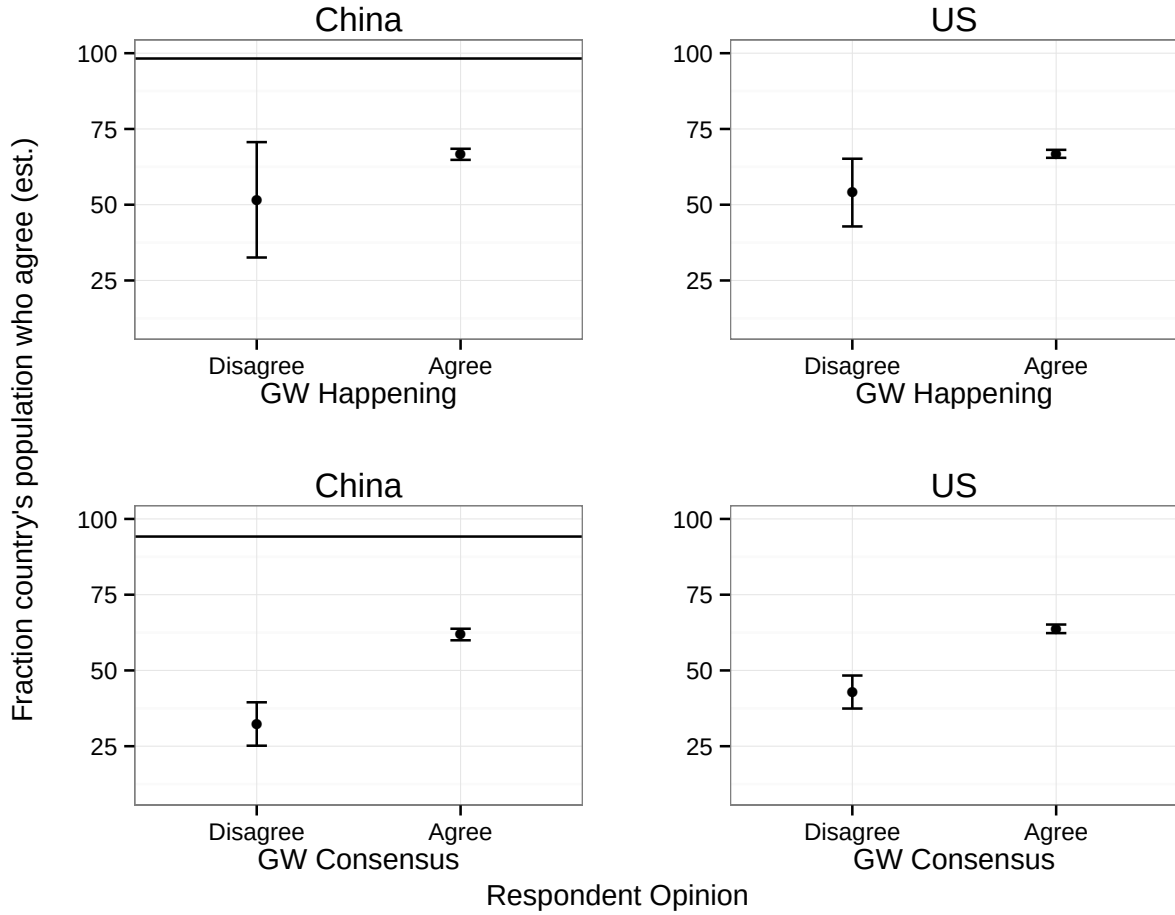


Figure 6: Estimates by Chinese citizens of Chinese (left column) and US (right column) population agreement with statements about science statements, conditional on individual belief type of Chinese survey respondents. *GW Happening* = “Global warming is happening.” *GW Consensus* = “Most scientists think global warming is caused by human activity.” The horizontal line on each graph gives the true national level of agreement with these statements (as estimated by the March 2015 nationally representative SSI survey in China). Error bars give the 95% confidence intervals.

at perceptions of US beliefs about *Chinese* policy, the egocentric bias is substantially reduced, which is consistent with our results from the US sample. This mirrors evidence that US citizens reveal attenuated egocentric bias in their second-order beliefs about Chinese policy preferences.⁸

⁸Interestingly, the extent of attenuation of egocentric bias is greater in both the US and China for

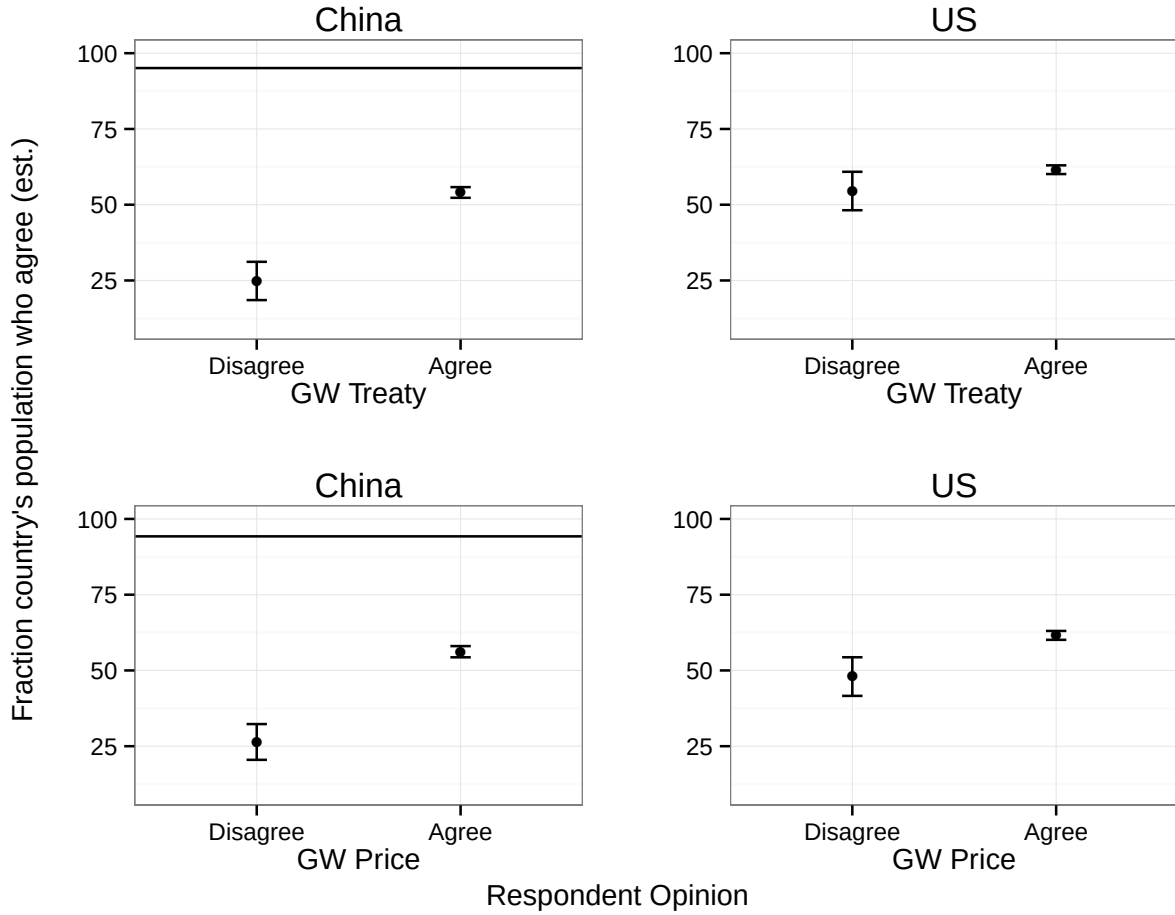


Figure 7: Estimates by Chinese citizens of Chinese (left column) and US (right column) population agreement with statements about *Chinese* policy, conditional on individual belief type of Chinese survey respondents. *GW Treaty* = “China should sign treaty requiring 90% cuts by 2050.” *GW Price* = “China should put price on pollution.” Error bars give the 95% confidence interval. The horizontal line on each graph gives the true national level of agreement with these statements (as estimated by the March 2015 nationally representative SSI survey in China). Error bars give the 95% confidence intervals.

Finally, it is instructive to broadly compare US and Chinese perceptions of the distribution of beliefs in each others’ populations. Comparing second-order beliefs about climate science-related questions (e.g. Figure 4 and Figure 6), Americans perceive lower policy questions, which can be seen in Figures ?? and 7.

levels of climate beliefs in China than in the US; by contrast, Chinese respondents report similar second-order beliefs about agreement with climate science statements in the two countries. Moving to climate policy-related questions (e.g. Figure 4 and Figure 7), respondents in both countries believe that the population of the other country has inflated beliefs about support for climate reforms in their country. That is, Americans believe that Chinese citizens believe that Americans are more supportive of climate policies than Americans believe that Americans are. Similarly, Chinese citizens believe that Americans believe that Chinese citizens are more supportive of climate policies than Chinese citizens believe that Chinese citizens are. That others expect an actor to behave more in a pro-climate fashion than the actor themselves expects has ambiguous implications for climate collective action. On the one hand, it could create stronger social pressures to conform with these expectations. On the other hand, this discrepancy could undermine the credibility of any climate commitment if individuals are aware of the other actor’s lower perceptions of a commitments’ credibility.

4.4 Reinforcing Social Contexts

What might explain the patterns of egocentric bias that we observe in our data? One possibility is that individuals tend to be more likely to talk with others who agree with them. This could happen in two ways. The first is just access to others is non-random. The second is that there might be differential willingness to engage with other individuals depending on the the concordance of beliefs. We explore this later mechanism, leaving for future work the former.

To explore whether asymmetric patterns of communication about climate change might reinforce these egocentric estimates of the distribution of climate beliefs, we asked subjects about their discursive willingness to engage in conversations about climate change with other people holding a range of beliefs about the existence of climate change. We define two belief types: (i) people who believe climate change is happening (ii) people who believe climate is not happening. We measure comfort levels on a scale of Very Uncomfortable (1) to Very Comfortable (5). Here our sample is only for the United

States and comes from our national representative SSI survey.

When we look at the distribution of comfort levels, conditional on respondent belief type, we see some interesting variation. Generally, people are more comfortable speaking about climate change with those who share their beliefs; however, this tendency is slightly more pronounced among climate believers. Disbelievers are more likely to express neither comfort or discomfort around who they communicate about climate change with.

This asymmetric comfort in communication about climate change presumably acts as a further subtle barrier to organizing collective action on climate change. This is because it reinforces biased views of the second-order distribution of climate beliefs. If climate disbelievers are more comfortable expressing their views, then their views will tend to be slightly over-represented within conversations about climate change between members of the public. This will incorrectly validate the biased second-order climate beliefs that we have already identified in the US population at large.

4.5 Rationales for the Climate Beliefs of Others

Our final empirical analysis turns to understanding perceptions of the rationales that other individuals would give for their opinion on climate change. That is, in the previous sections we explored perceptions of *what* views are held by other individuals, this section unpacks the *why*. That is, we wanted to know what people think the reasons 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. Then, we took those open ended responses and analyzed them using recent advances in textual analysis to see if the topics people wrote about differ depending on whether the survey respondent’s belief of whether or not climate change is happening.

Our first prompt dealt with whether or not climate change is happening. Specifically, the prompt 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 simulate someone who thought climate change was happening or that climate change was not happening.

To analyze this open ended data we utilize the Structural Topic Model (STM), 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 allows investigating whether a covariate related to each document explains a propensity to talk about particular topics. In our case, we are interested whether individuals in our survey who differ on whether or not climate change is happening *also* think that individuals would give different rationale’s for why others hold an opinion. For example, in responding to a prompt about why someone holds a 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 using whether the respondent thinks climate change is happening, whether someone got the prompt about climate change happening or not, and an interaction between these two variables, as topic prevalence parameters. Figure 9 plots the results. The top left of the plot provides a list of words for each topic that are highly exclusive to the topic. These words help to discern differences between the topics. For example, topic 1 deals with the influence of the liberal agenda via media to try and take power via government regulation. Topic 2 is a topic 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 in the climate change not happening versus happening conditions. The bottom half of the figure plots the relationship between topics and respondent’s own views on whether climate change is happening.

Interestingly, the differences between respondents who believe climate change is hap-

pening versus not are substantively small and in every case statistically insignificant. While a larger sample would likely reduce our confidence intervals, the point estimates of the differences are small. This suggests that individuals on both sides of this issue have similar beliefs about the topics that others might draw on when it comes to substantiating their views. We take this as evidence in support of there being common knowledge about rationales.

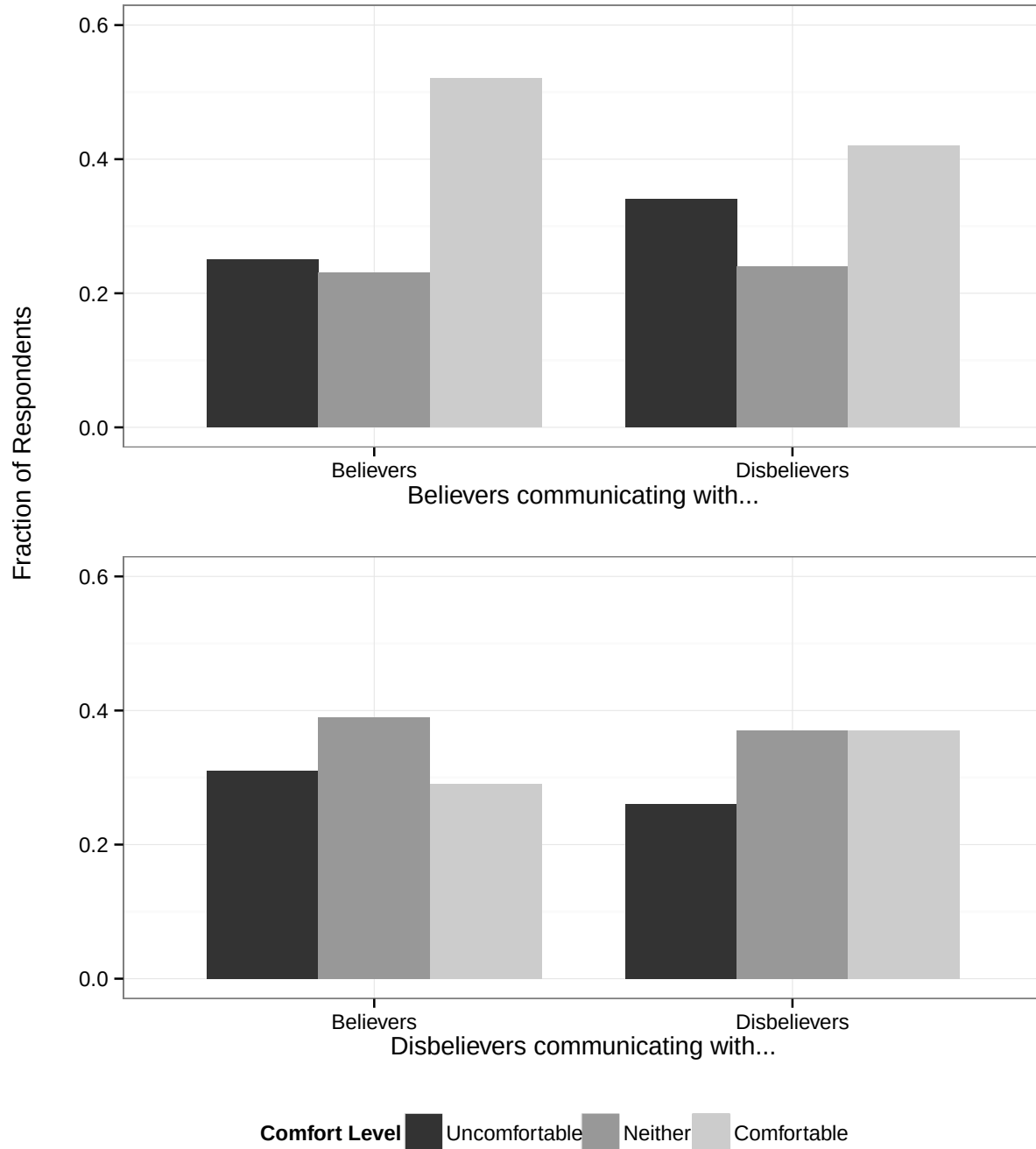


Figure 8: Respondent comfort communicating with climate believers and disbelievers, by individual belief type. The top panel shows reported comfort by people who believe in climate change, communicating with individuals who believe (left) or disbelieve (right). The bottom panel shows the analogous comfort levels of climate change disbelievers. “Comfortable” includes individuals who report being Very Comfortable or Somewhat Comfortable communicating with a given belief type. “Uncomfortable” includes individuals who report being Very Uncomfortable or Somewhat Uncomfortable communicating with a given belief type.

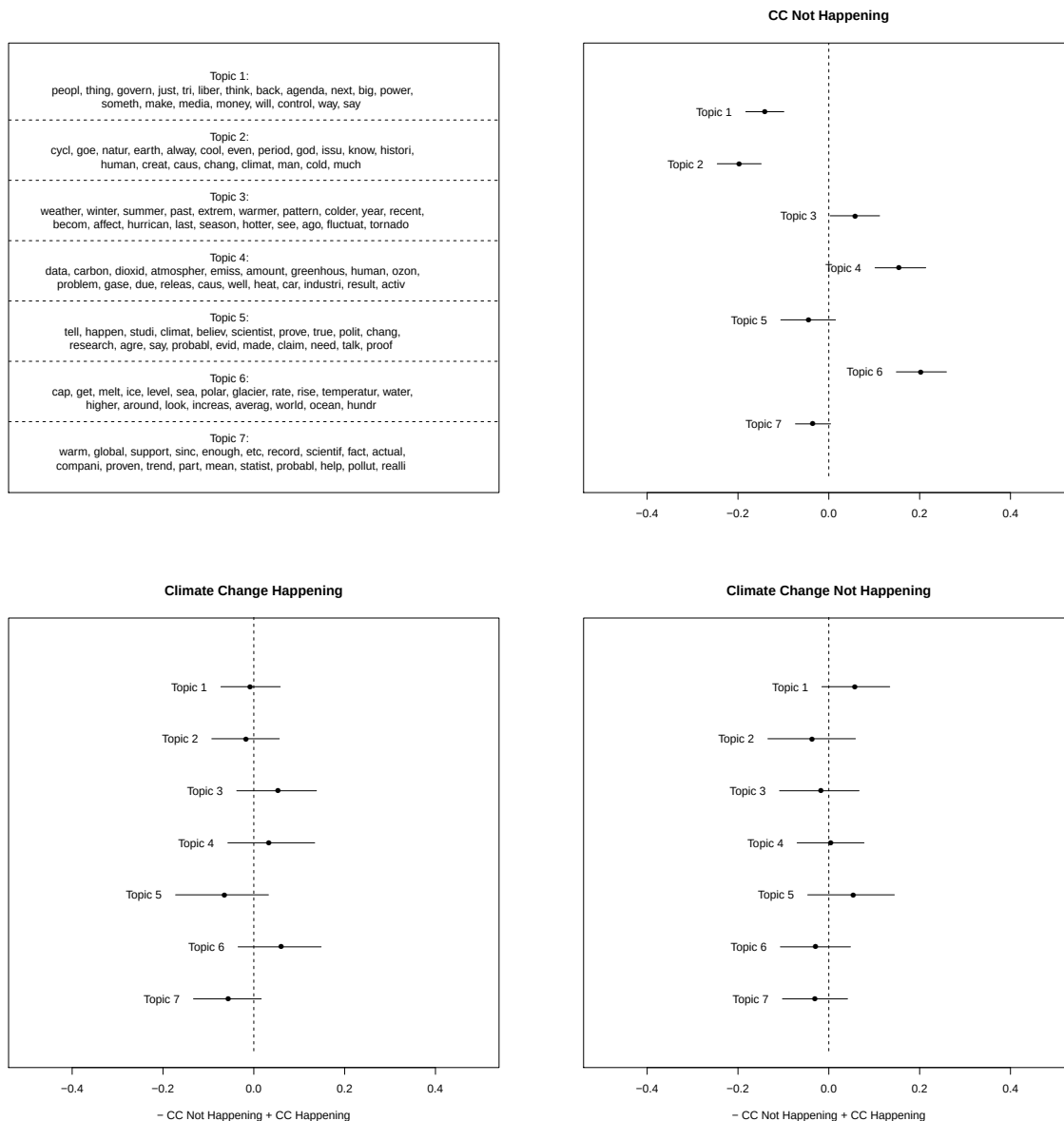


Figure 9: Top left of figure lists words highly exclusive to each topic. Top right gives the topic contrast between those in the climate change not happening versus happening conditions. Bottom half of figure plots the relationship between topics and respondent's own views on whether climate change is happening. The left hand plot is for people who were asked to write about 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.

We also asked another set of respondents a different prompt, aimed to understand perceptions of political actors more directly. 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 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...”

Figure 10 presents the results. The format is the same as in Figure 9. The top left plots words highly exclusive to reach topic and the top right plots the differences across whether someone was asked to write about a politician arguing that humans do, or do not, cause climate change. Topics 5 and 7 pickup the main themes for politicians that 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 things 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. As in the previous results we see no substantial differences across individual in our survey. Individuals on both sides of the climate change debate have similar understandings of the rhetoric used by both sides of the debate.

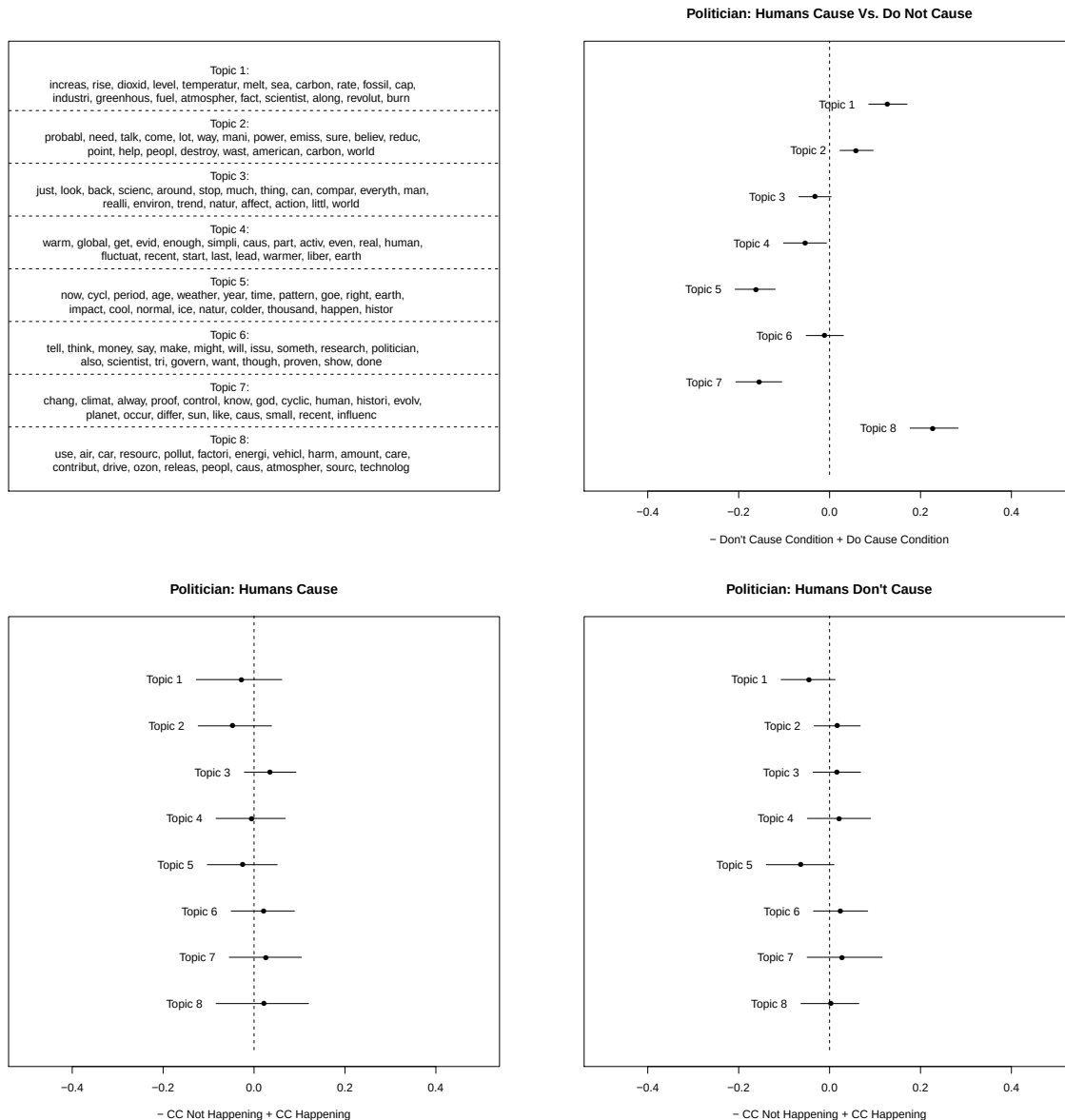


Figure 10: Top left of figure lists words highly exclusive to each topic. Top right gives the topic contrast between those in the climate change not happening versus happening conditions. Bottom half of figure plots the relationship between topics and respondent's own views on whether climate change 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 more likely to be mentioned by an individual who does not believe climate change is happening.

5 Discussion

Recently several political scientists have bemoaned the lack of systematic attention on the issue of climate change (Javeline, 2014; Keohane, 2015). We agree, and focus in on the implications of climate change for an issue central to collective action. Rather than study the propensity to free ride or cooperate (if other’s cooperate) (e.g., Tingley and Tomz, 2013), or responses to cost and institutional design issues (Bechtel and Scheve, 2013), we focus on beliefs. In particular, we focus on the “second-order” beliefs: beliefs that individuals have about the beliefs of others.

Second-order beliefs are important for climate cooperation in several respects. For example, Robert Keohane notes how “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” Keohane (2015, pg. 24). Yet, 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 individual perception of the beliefs of others, our focus in this research.

Consistent with literature on second-order belief formation in psychology, we find systematic evidence that individuals condition their perceptions of these group beliefs on their individual opinions. While previous work has examined second-order beliefs in Australia, we find evidence for systematic biases both the United States and China, the two largest carbon polluters in the world. We expect that these biases work against efforts to coordinate climate policy action. If 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. This effect is reinforced by asymmetry in climate communication patterns, with those who disbelieve in climate change more comfortable than those who believe to communicate their viewpoints with individuals who do not share their beliefs.

At the same time, we find evidence of common knowledge in the domain of ratio-

nales. While there are various divergences between second order beliefs about support for different policy positions, general awareness of competing rationales seems quite stable. 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 they 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, 2014), 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.

Overall, these results suggest that the structure of second-order climate beliefs may be a further obstacle to collective climate action. Climate cooperation is difficult to incentivize when individuals disagree on the nature of the potential risks of action or inaction. However, we find evidence that these differences are reinforced by biased perceptions of the distribution of climate beliefs in the US population, differences that do not seem to be linked to a lack of understanding of others’ perspectives. At the same time, 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, it may be possible to identify strategies to leverage this understanding into common support for policy action. Similarly, while recent research has focussed on increasing second-order beliefs about elites, in particular 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 the distribution of climate beliefs in the general public may also be a promising strategy to

generate climate policy momentum.⁹

⁹Of course, climate polling can easily turn 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.

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