**Tweeting About Climate: Which Politicians Speak Up and What Do They Speak Up About?**

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**Abstract**

This study examines tweets (N=1,103,119) sent by 638 US politicians regarding climate change (N=10,135). Using data reflecting the risks faced and opinions held by their constituents, the extent to which politicians lead—tweeting about climate change for those most at risk, called trusteeship—or follow—tweeting about climate change for those who are already concerned, called playing to the crowd—is examined. Results reveal that while Democrats generally tweet about climate change more often than Republicans, within each party, tweeting frequency is mostly explained by the level of concern in a politicians’ constituency. Objective risks faced by constituents play no role. Analysis of behavior across different office levels—federal, state, and local—also shows that while federal politicians are more partisan, state and local politicians play to the crowd to a greater degree. Analysis of the tweets shows the politicians’ unequal engagement leads to over-representations of some topics (e.g., “calls for action”) and under-representations of other topics (e.g., criticizing fossil fuels and deniers).

**Keywords**

Twitter, climate change, politics, topic modeling

Social media offers politicians the opportunity to communicate directly with the public (Cook, 2016a, 2016b; Veltri & Atanasova, 2015). This direct line of communication is particularly important when discussing complex issues informed by expert research, such as related to science. In these cases, elected government officials often have an information advantage over their constituents through access to expert reports as well as staff that can help them interpret the relevance of complex information for their constituencies. In such cases, it is important that politicians play the role of trustees who protect the public interest (Fox & Shotts, 2009). A trustee uses “her [his] expertise and pursue policies that she [he] believes promote the general welfare” (Fox & Shotts, 2009, p. 1225). Trusteeship acknowledges that for complex, technical matters, elected leaders generally have an information advantage over citizens (Lazer et al., 2012). In particular, politicians themselves can be opinion leaders, shifting public opinion with their statements and actions (Slothuus, 2010), and thus, democracies depend on politicians acting as trustees to build consensus and support on scientific issues. Social media can facilitate trusteeship by enabling politicians to bypass other gatekeepers (Golbeck et al., 2010; Karlsen & Enjolras, 2016), communicating directly with the public about the issues they face.

However, another feature of social media is that it enables direct feedback from the public (French & Bazarova, 2017; O’Sullivan & Carr, 2018). This potential for direct feedback creates incentives for politicians to follow, rather than lead, the public’s perceptions, encouraging them to “play to the crowd” by discussing the topics their voters already care about than act as trustees (Boydston et al., 2013). Politicians can also gain electoral advantages by talking more about the issues that, according to pre-existing public perceptions, are “owned” by their political parties (Ansolabehere & Iyengar, 1994).

This raises basic questions about the nature of political discourse on scientific and other “expert” topics on social media. To what extent do politicians on social media act in...
the role of leaders—trustees of the public interest? To what extent do they act in the role of followers—shaping their discourse to match existing public perceptions and opinions? And to what extent do they simply follow the interests of their party? Do these tendencies change with the scope of their office, and how do these differences shape the overall voice of politicians on social media?

In this study, we address these questions in the context of politicians’ talking about climate change on Twitter. We compare the extent to which a politician tweets about climate change to the extent to which their constituents face direct risks from climate change, requiring their trusteship, or are already concerned about climate change, encouraging them to play to the crowd.

Literature Review

Which Politicians Talk About Climate Change

Whether politicians speak up, or remain silent, about an issue, as well as the aspects that they choose to emphasize when they speak, is an important factor in shaping both public and government response. First, politicians’ statements on social media can be influential as agenda setters. By mentioning a topic, they draw news media attention, and signal that an issue is worthy of public attention (Kiousis et al., 2006). This basic agenda setting is then amplified by journalists, who often rely directly on politicians’ posts, particularly on Twitter, to find material for their news stories (Parmelee, 2014). Moreover, in the case of climate change, media attention is then an important predictor of government action (Bromley-Trujillo et al., 2014). In addition, politicians often use social media, particularly Twitter, as though they are short press releases signaling their policy intentions (Golbeck et al., 2010). Thus, the issues that politicians call out as important in their social media statements can have an important influence on public perception and debate.

This study focuses specifically on politicians’ tweets about climate change. While there is evidence that politicians’ engagement with climate change is becoming more prominent (Fownes et al., 2018), research to date has focused on politicians’ statements in mainstream news media (Hart & Feldman, 2014). Meanwhile, studies of social media communication about climate change have emphasized non-political opinion leaders, such as scientists (Lee et al., 2018), celebrities (Liu & Zhao, 2017), or “non-personal” accounts (Pathak et al., 2017).

Thus, the extent to which the opportunities offered to politicians by social media to lead the public—informing them as trustees—or to follow the public—reflecting their existing opinion—has not been examined. In this study, we formally describe these dynamics by considering three roles that politicians may play with respect to climate change, depending on who mentions the issue in their tweets: issue ownership, that is, partisan electoral advantage; playing to the crowd; and representation as trusteeship, that is, the responsibility to protect a public that has limited information. We review each below.

Issue Ownership. Politicians of different parties not only hold different opinions on the same issues, but they also focus on different issues. One important reason for this is that voters tend to associate issues with the competencies of particular political parties or types of candidates, assuming that they will be better able to handle them (Ansolabehere & Iyengar, 1994; Petrocik et al., 2003). As a result, for important issues, voters prefer candidates with perceived competencies to address that issue. For example, if sexual harassment is seen as an important issue, voters are more likely to vote for a female candidate (Ansolabehere & Iyengar, 1994). More broadly, naming an issue gives it mental salience, making it appear worthy of attention even if the politician is arguing against its importance (Lakoff, 2004). For this reason, politicians tend to avoid addressing issues where they are not considered strong, rather than confronting them (Boydston et al., 2013).

Parties as a whole can also own an issue. When issues are “owned” by a particular party, voters support that party when they view that issue as important. In essence, if voters believe that the issue is important, they will assume that the “owning” party is more competent in addressing the issue and reward them with more power. Thus, it is always in the “owning” party’s interest to highlight the impact and importance of that issue and any “non-owning” party’s interest to downplay it, irrespective of the policies individual politicians may prefer (Meeks, 2015).

In the United States, Democrats are perceived to own protection of the environment, of which climate change is becoming an increasingly central component (Bailey, 2015). Thus, irrespective of public beliefs regarding climate science or the scientific risks climate change poses, Democrats have an incentive to bring up the topic of climate change as an important issue and Republicans have an incentive to ignore it and try to get attention for other, unrelated issues (e.g., taxes, immigration). Importantly, for Republicans, talking about climate change, even to deny it as a real issue or to criticize mitigation efforts, is to give the issue attention that encourages voters to take their opponents (Democrats) more seriously. For example, in the 2020 election campaign, Democrats included climate change in their platform and held a town hall discussion of the issue on the Cable News Network (CNN; Wagner et al., 2019). Thus,

Hypothsis 1 (H1): Democrats will communicate about climate change more often than Republicans.

Playing to the Crowd. Politicians in a representative democracy have a strong incentive to publicly display the extent to which they share the concerns and values of their voters.
Such displays are known as “playing to the crowd” (Boydstun et al., 2013). When playing to the crowd, a politician may downplay the real issues that their constituents are facing, and may also bely the actions they are actually taking in their official roles. This tendency lies at the heart of long-standing concerns about representative democracy’s ability to respond to issues that require substantial technical expertise to comprehend (Schudson, 2008).

Previous studies show that playing to the crowd is a common strategy for politicians to please their constituents, especially when politicians want to win more votes from them (Ansolabehere & Iyengar, 1994; Boydstun et al., 2013). In the case of climate change, playing to the crowd means that politicians whose constituents are worried about climate change should talk about it a lot on social media, and those whose constituents are not worried should talk about it less.

Importantly, politicians in a representative democracy can also be seen as playing the role of “delegates,” carrying out the wishes of their constituents rather than shaping them (Fox & Shotts, 2009). The distinction between playing to the crowd and acting as a delegate depends on the audience targeted by the politicians’ communication. Politicians act as delegates when they communicate their constituents’ concerns to their colleagues in power. When communicating directly to the public, the delegation aspect of their communication is more limited and the playing to the crowd aspect more salient (Stiglitz & Caspi, 2020).

Because social media provide a direct way to reach the crowd, it is expected that politicians will have incentives to reflect the level of climate change concern among their constituents when choosing whether or not to communicate about climate change:

Hypothesis 2 (H2): The more politicians’ constituents are concerned about climate change, the more the politicians will communicate about climate change.

Leading as Trustees. When considering a social issue in which expert knowledge is needed, politicians can also have a responsibility to act as trustees. When playing to the crowd, a politician follows her or his constituents’ pre-existing beliefs, values, or concerns. When acting as a trustee, by contrast, the politician leads the public by using her or his expertise to promote the general welfare, even if this means supporting ideas the public does not yet accept (Fox & Shotts, 2009).

Trusteeship can be advantageous to communities when the underlying issues are complex, requiring expert analysis. For example, the assessment of climate change depends on an expert consensus published in technical reports such as those from the Intergovernmental Panel on Climate Change (IPCC) and the US National Climate Assessment. In addition, government agencies at the federal, state, and local levels require information specific to their location’s impacts and vulnerabilities (Rosenzweig et al., 2011). While research often laments the general public’s limited understanding of this information (Schäfer, 2012), this gap between expert and public understanding is precisely what a representative democracy, via trusteeship, is supposed to address. Lazer and colleagues (2012) describe a process of representation in which legislators “debate and craft policies to advance [constituent] interests and persuade their constituents of the (sometimes nonobvious) connection between the two” (p. 267). Consistent with this ideal process, there is evidence that voters tend to take cues from their leaders regarding which position to take on an important issue (Slothuus, 2010).

As trustees on climate change, those in office should consult experts about the objectively determined risks of climate change to their constituents and then persuade constituents to alter their opinions to be in line with these scientific facts. That is, politicians speaking as trustees should call attention to climate change when their constituency will be directly affected by objectively projected climate change impacts.

Hypothesis 3 (H3): The more severe the scientifically projected risk of climate change impacts to a politician’s constituency, the more the politician will communicate about climate change.

Scope of Responsibilities. The preceding arguments apply broadly to any politician addressing a scientific issue. However, we note that these dynamics may be substantially moderated by the scope of responsibilities a politician holds. More local “lower level” governments tend to have better accountability, responsiveness, and representativeness than the central government (Beetham, 1996). Lower level politicians are closer to their constituents and thus are more likely to take local citizens’ voices into consideration when putting forward policies. These factors suggest that both playing to the (local) crowd and leading via trusteeship may be enhanced at the expense of focusing on issue ownership. Consistent with this idea, there is some evidence that state and local politicians are taking actions that deviate from issue ownership logic, such as the US Climate Alliance (http://www.usclimatealliance.org/about-us) and Climate Mayors (https://climatemayors.org/who-we-are), bipartisan coalitions of governors and mayors committed to combating climate change.

Yet, there is a decreasing voter turnout in local elections in recent years and Americans pay disproportionately more attention to federal than local political news (Hajnal & Lewis, 2003; Hopkins, 2018). Furthermore, while local politicians can work to help their communities adapt to the effects of climate change, addressing and mitigating climate change itself requires cooperation at the supra-national level. Thus, local politicians may see climate change as a “national issue” that is not relevant to their constituents, at least as far as their responsibilities go. Previous research has not examined the potential dynamics of issue ownership, playing to
the crowd, or trusteeship across levels of office scope. This raises a question of whether local, state, and federal politicians differ in their tendency to use climate change tweets to play the three roles we have proposed. Thus, we ask the following:

Research Question 1 (RQ1): How do the tendencies to use issue ownership, play to the crowd, or lead as a trustee interact with the geographic scope of politicians’ responsibilities (local, state, federal)?

The Impact of the Three Roles on Twitter Discourse

Above we hypothesize that different elected officials may be more or less likely to discuss climate change on Twitter in three roles: issue ownership, playing to the crowd, and representation as trusteeship. This analysis focuses on the important power of simply mentioning a topic, bringing it to the public’s attention. As such, it compares politicians who speak up on the issue to those who remain silent. However, if such differences are apparent, this also raises the question of how these differences influence the agenda building work done by the subset of elected officials who do mention the topic. In particular, if the more vocal politicians, according to this analysis, emphasize different sub-topics of the issue differently than the less vocal politicians, this may “bias” the discourse in the sense that it sets the climate change agenda toward the issues important to the more vocal groups. We thus ask the following:

Research Question 2 (RQ2): What climate change themes are uniquely associated with the more vocal groups of politicians on Twitter?

Methods

In this study, we classify US senators and representatives as federal politicians, governors as state politicians, and mayors as local politicians. We then collected data for all voting members of the 115th Congress, governors of the 50 states, and mayors of the 100 most populous US cities (ranked by 2010 Census) who had active Twitter accounts during the time period of this Congress. We chose the top 100 largest cities for both substantive and methodological reasons. First, large cities are critical players in climate change. They contribute a substantial portion of greenhouse gas emissions (though generally less on a per capita basis). Large cities are also active in supporting climate change deals (e.g., The C40 Cities Climate Leadership Group). Second, as cities become smaller, the likelihood that their mayors have Twitter accounts decreases. For instance, among the top 100 mayors, there are 87 mayors who had Twitter (58 Democrats, 21 Republicans, and 8 Independents); among the next 100 mayors (101st–200th by population), there are only 69 with Twitter accounts (42 Democrats, 15 Republicans, and 12 Independents).

Since different levels of politicians took office at different times and have different term limits, we decided to use the 115th Congress term as our timeline (3 January 2017 to 3 January 2019) for all politicians. Senators’ terms cover this time period. Most governors and mayors have terms longer than 2 years, but some elections happened during the 115th Congress term (two governors and nine mayors). In these cases, we used the following strategy: if those elections happened before 2018, we included the elected politicians (successors) in our dataset; if those elections happened after 2018, we chose their predecessors.

Independent or nonpartisan politicians were not included in our study because of the small sample size (2 senators, 1 governor, and 8 mayors among 649 politicians) and for the purpose of clarity of presentation. For all the politicians’ Twitter accounts, we avoided using their campaign accounts as they might affect their incentives on communication and framing of climate change. The final dataset for analyses comprised tweets from 638 Democrats and Republicans who had Twitter accounts and tweeted during the 115th Congress term (see Table 1).

Table 1. Democratic and Republican Politicians of Different Office Levels.

| Office level     | Totala | Had Twitter account and tweeted during the 115th Congress term | Democrats | Republicans |
|------------------|--------|---------------------------------------------------------------|-----------|-------------|
| Senators         | 98     | 46                                                            | 52        |             |
| Representatives  | 435    | 191                                                           | 223       |             |
| Governors        | 49     | 19                                                            | 28        |             |
| Top 100 mayors   | 92     | 58                                                            | 21        |             |

aExcluding independent or nonpartisan politicians.

Measures

Tweets. Congress members’ tweets were drawn from the 115th US Congress Tweet ID dataset (Littman, 2017). Governors and mayors’ tweets were gathered by Twitter’s REST API. The API allows the user to download the most recent 3,200 tweets (including retweets) from a Twitter handle. In practice, none of the governors had more than 3,200 tweets, and only two mayors (Mayor Joe Hogsett of Indianapolis, IN, and Mayor Buddy Dyer of Orlando, FL) had exceeded...
the limit when we collected their data. During the 115th Congress term, there are 915,652 tweets from members of Congress ($M=1,784.897, SD=1,544.130$), 63,452 tweets from governors ($M=1,350.043, SD=866.578$), and 124,015 tweets from mayors ($M=1,569.810, SD=1,089.353$).

**Climate Change–Related Tweets.** To determine which tweets addressed the issue of climate change, we began with keywords—global, warming, climate, change—that previous studies (e.g., Cody et al., 2015) suggest should have reasonably high precision (identifying only the relevant tweets) and recall (identifying all the relevant tweets). To find out a set of search terms that had an optimal balance of precision and recall, we did a pilot study on a sample of tweets ($N=3,857$). We first coded the tweets to determine whether they were in fact about climate change using Figure Eight, a crowdsourcing platform, with acceptable inter-coder reliability for this task (Krippendorff’s $\alpha=.876$, 490 crowdsourced human coders from the platform participated in this work). We then calculated the precision, recall, and the F1 score ($0 \leq F1 \leq 1$, 1 means perfect precision and recall) for each coded term. Results (see Table 1 in Online Appendix) indicated the search term of “climate OR (global AND warming) NOT (business climate OR economic climate OR biz climate OR tax climate OR regulatory climate)” provided the best result (precision=$0.867$, recall=$0.961$, $F1=0.911$). We thus used this search term which identified 10,135 climate change tweets among all the politicians’ tweets during the 115th Congress term. Specifically, 8,964 of the climate change tweets are from members of Congress ($M=26.211, SD=64.674$), 373 of the tweets are from governors ($M=13.815, SD=27.873$), and 798 of those tweets from mayors ($M=15.647, SD=21.163$).

**Climate Change Concerns.** The concern data were obtained from the 2018 Yale Program on Climate Change (YPCC; Leiserowitz et al., 2018). Data were available at state, county, and congressional district levels based on cross-validated models created using nationally representative surveys from 2008 to 2018. To represent the average public sentiment toward climate change, we selected estimates of public opinion on four survey questions from the YPCC: estimated percentage who (1) think that global warming is happening (happening); (2) think that global warming is caused mostly by human activities (human); (3) very worried about global warming (worry); and (4) think global warming will harm them personally a moderate amount/a great deal (personal harm).

City-level estimates were mapped from county-level data by population. That is, we first calculated the percentage of the population in each city in their county(ies) based on census population data from 2010 Census, and then mapped the county-level data to the city level. For instance, if the percentage of population who think that global warming is happening (happening) in County 1 and County 2 are 65% and 80%, and 20% of City A’s population is in County 1 and 80% of the population is in County 2, then the percentage of the population who have the same opinion (happening) in City A is 77% (20%*65%+80%*80%). State-level and congressional district-level estimates were directly pulled from the YPCC data. For senators and governors, their constituencies are at the same (state) level.

Within the city, congressional district, and state levels, these four measures (global warming happening, causes, worry, and harm) were all significantly correlated with each other (Pearson correlation coefficients of the four measures within the city, congressional district, and state levels range from .762 to .947, from .880 to .959, and from .930 to .979, respectively), suggesting that one factor might reasonably represent all measures. Results of principal component analysis showed that there was one principal component that explained 90.86%, 94.13%, and 96.56% of the total variance at city, congressional district, and state levels respectively. Therefore, we used the above components to represent all the four measures of concerns about climate change at the three levels.

**Climate Change Risk.** The risk was defined as the projected percentage of economic damage on per capita income. Data were obtained from Hsiang and colleagues’ study (Hsiang et al., 2017) that measured the median annual damage at the county level (% county per capita income) during 2080–2099 under a business-as-usual scenario. These estimates include the impact of climate change via elements including agriculture, storms, energy, and human mortality on both “market and nonmarket costs” (Hsiang et al., 2017, p. 1362). State-level risk data were aggregated from county-level data weighted by population. City- and congressional district-level risk data were converted from the county level by the same geographic mapping method used in the conversion of climate change concerns.

**Analytical Procedures.** To analyze our hypotheses and RQ1, we used a generalized linear mixed model with a binomial distribution and a logit link using lme4 package in R. The model had a fixed effect of party affiliation, concerns about climate change, the economic risk of climate change, office levels, and a random effect of politicians.

To explore RQ2, we use the unsupervised Latent Dirichlet Allocation (LDA)-based topic modeling. We select this method over alternatives (e.g., word2vec; Pathak et al., 2017) as our focus is on the overall themes of the tweets, rather than specific word meanings. In addition, LDA topic modeling enables us to further investigate the distribution of the global topics (themes) in each politician’s tweets, which is directly related to RQ2.
To prepare the tweets for topic modeling, we followed previous studies’ text cleaning procedures (Guo et al., 2016) and aggregate tweets by 420 (288 Democrats and 132 Republicans) of 638 politicians who tweeted about climate change. The LDA-based topic modeling can produce any number of topics (Blei & Lafferty, 2009). We followed Bian and colleagues’ (2016) method to manually evaluate the topics generated by different number of topics, and we decided that 10 topics are sufficient to illustrate our climate change tweets. To determine the meaning of each topic, three researchers read all the 10 most probable terms from each topic and suggested a label for each topic. We also applied word and topic intrusion tests to further boost confidence and validity of the 10 identified topics (see Online Appendix for details).

**Results**

Table 2 presents the summary of logistic regressions predicting the probability of politicians’ tweeting about climate change. Model 1 presents results for H1–H3, which indicate that Democrats have higher probability of tweeting about climate change than Republicans ($B=1.514$, $SE=0.135$, $p<.001$). This supports H1. The probability of politicians’ tweeting about climate change is positively associated with constituents’ concerns ($B=0.555$, $SE=0.057$, $p<.001$), supporting H2. The probability of politicians’ tweeting about climate change is negatively associated with climate change risks to their constituencies ($B=-0.389$, $SE=0.049$, $p<.001$). This does not support H3.

Since issue ownership has strong effect of tweeting climate change, we thus test the effect of concerns and risks

| Probability of tweeting climate change | (1) | (2) | (3) |
|---------------------------------------|-----|-----|-----|
| Democratic                            | 1.514*** | 1.090*** | 1.104*** |
| (0.135)                               | (0.305) | (0.330) |
| Concerns                              | 0.555*** | 0.695*** | 0.244* |
| (0.057)                               | (0.090) | (0.110) |
| Risks                                 | −0.389*** | −0.543*** | −0.093 |
| (0.049)                               | (0.083) | (0.107) |
| State level                           | −0.093 | −0.206 | −0.406*** |
| (0.442)                               | (0.443) | (0.138) |
| Federal level                         | −0.198 | −0.325 | −0.046 |
| (0.329)                               | (0.335) | (0.127) |
| Income                                | 0.643*** | 0.639 | −0.821* |
| (0.092)                               | (0.349) | (0.414) |
| State level*Income                    | −0.821* | −0.463 | −0.495*** |
| (0.113)                               | (0.290) | (0.414) |
| Democratic*State level                | 0.414 | 0.407 | 0.343** |
| (0.577)                               | (0.382) | (0.127) |
| Democratic*Federal level              | 0.914*** | 0.928* | −0.008 |
| (0.351)                               | (0.371) | (0.138) |
| State level*Concerns                  | 0.097 | 0.639 | 0.044 |
| (0.280)                               | (0.349) | (0.259) |
| Federal level*Concerns                | −0.406*** | −0.008 | 0.359 |
| (0.121)                               | (0.138) | (0.105) |
| State level*Risks                     | 0.044 | −0.463 | 0.343** |
| (0.259)                               | (0.290) | (0.127) |
| Federal level*Risks                   | 0.343** | −0.046 | −6.722*** |
| (0.105)                               | (0.127) | (0.098) |
| Constant                              | −6.877*** | −6.845*** | −6.722*** |
| (0.098)                               | (0.309) | (0.316) |
| Observations                          | 638 | 638 | 638 |
| Log likelihood                        | −1,774.518 | −1,759.024 | −1,729.148 |
| Akaike information criterion          | 3,559.035 | 3,544.048 | 3,490.296 |
| Bayesian information criterion        | 3,581.327 | 3,602.007 | 3,561.630 |

*p<.05; ***p<.01; ****p<.001.
within each party to see if the influences of delegates (concerns) and trusteeship (risks) still hold. Results (see Table 3 in the Online Appendix) show that concerns play an important role within each party and the effect is stronger with Democrats ($B=0.557, SE=0.062, p<.001$) than Republicans ($B=0.399, SE=0.144, p<.001$). This shows that playing to the crowd takes place within both parties, but is actually stronger among Democrats. While the risk level is still negatively related to tweeting about climate change within the Democratic Party ($B=-0.467, SE=0.058, p<.001$), it is no longer significant within the Republican Party ($B=-0.175, SE=0.095, p>.001$).

Our RQ1 asks how politicians’ tendencies to use issue ownership, play to the crowd, or lead as a trustee interact with their scope of responsibilities (local, state, federal). To explore this question, we added interaction terms between the office level and party, constituents’ concerns, and constituencies’ climate change risk (see Model 2). Results show that there are significant interaction effects between federal politicians and Democratic Party ($B=0.914, SE=0.351, p<.01$), concerns ($B=-0.406, SE=0.121, p<.001$), and risks ($B=0.343, SE=0.105, p<.01$), respectively.

To better understand the results in Model 2, we used pairwise comparison of estimated marginal means and odds—the ratio of the probability of tweeting climate change and the probability of not tweeting climate change—to make a more intuitive interpretation (see Table 2 in Online Appendix). The estimates indicate that for Democrats, the odds of tweeting about climate change are 2.97 times ($SE=0.908, p=.0004$), 4.50 times ($SE=2.204, p=.0021$), and 7.42 times ($SE=1.282, p<.0001$) as large as the odds for Republicans at the local, state, and federal levels, respectively. This shows that the partisan difference in the tendency to tweet about climate change increases as office levels move from local to federal.

The estimates of pairwise comparison also indicate that local and state politicians vary their tweeting behaviors more with constituents’ concerns than do federal politicians. For federal politicians representing concerned citizens (those with concerns 1 standard deviation above the mean), the odds of tweeting about climate change are 1.78 ($SE=0.292, p<.001$) larger than for those representing unconcerned citizens (those with concerns 1 standard deviation below the mean). By contrast, this ratio jumps to 4.02 ($SE=0.721, p<.001$) for local politicians and 4.88 ($SE=2.592, p=.008$) for state politicians.

**Adding per Capita Income Data to the Model**

Estimates in Models 1 and 2 show that the climate change risks have persistently negative relationship to politicians tweeting about climate change. In other words, politicians representing high-risk districts tweet less about climate change. While this may indicate the politicians play the opposite role of trusteeship, another possible explanation for this counterintuitive result is access to resources. A major source of funding for climate change policies comes from government budgets (Keohane & Victor, 2011). Poorer governments may also focus more on short-term economic development than wealthier ones, so they are less focused on climate change. Thus, poorer communities may be less able to respond to climate change, making it a lower priority issue for politicians. If poorer communities also carry higher climate change risks, a negative correlation between tweeting and risk would be expected.

To test this idea, we used the per capita income as our proxy of governments’ resources. The income data were at the census tract level and were collected from 2017 American Community Survey (5-year estimates). We converted the income data to different office levels in our model using the same method we implemented in converting concern and risk data. Estimates in Model 3 in Table 2 show that while party affiliation and concerns about climate change still have consistent effect on politicians’ tweeting about climate change, risk is no longer a significant factor. In particular, income has a positive effect on politicians’ tweeting about climate change at both the local and federal office levels, but the effect is strongest at the local level ($B=0.643, SE=0.092, p<.001$). This finding is consistent with the explanation provided above.

**RQ2: Tweet Content**

The topic modeling results in Table 3 shows that the topic of “calls for action” (16.26%) has the largest proportion. In addition, many topics are evoked by events, especially political events such as “Trump & Paris Agreement” (11.66%), “California wildfires” (9.77%), and “EPA & climate march” (9.46%). There are also office-level-specific topics—“states’ solutions” (9.12%), “cities’ solutions” (8.75%), and “climate solution caucus” (8.46%).

We then extracted topic proportions for each politician’s tweets, and used linear regression to explore what climate change themes are uniquely associated with the most vocal groups of politicians on Twitter. The results in Model 3 of Table 2 show that Democrats, politicians representing more concerned constituents, and politicians representing wealthier constituencies are more likely to tweet about climate change in general. Particularly, federal Democrats, and federal politicians representing wealthy constituencies tend to speak up more than other politicians. Thus, the predictors in the regression model used for RQ2 are based on these significant predictors. Results in Table 4 show that only Topics 1, 6, 7, 9, and 10 are significantly influenced by at least one of the predictors. Constituents’ concerns do not have significant effect on any topic proportions. See Figure 1 for a visual illustration.

As shown in Table 4 and Figure 1, some topics are “overrepresented” in politicians’ statements on social media in that they are favored by the kinds of politicians that speak up more. Specifically, federal Democrats are more likely to
By contrast, other topics that are most popular within many important sub-groups of politicians are “under-represented” because of the overall popularity of “calls for action.” For instance, politicians representing lower income districts are less vocal than those from higher income districts, but they tend to tweet more about Topic 7 “criticizing fossil fuels & deniers” ($B = -0.019$, $SE = 0.007$, $p < .05$) and Topic 1 “Climate Solutions Caucus” ($B = -0.019$, $SE = 0.008$, $p < .05$). It is also worth noting that, for federal politicians, the probability of talking about Topic 1 increases as constituencies’ income level increases (income*Federal: $B = 0.025$, $SE = 0.008$, $p < .01$). Other office-level-specific topics are also “under-represented.” For example, mayors (local) emphasize “cities’ solutions” (8.75%) and governors (state) emphasize “states’ solutions” (9.12%), but these emphases are lost in the overall discourse because federal politicians tweet substantially more about climate change than mayors and governors do, but tweet substantially less about “cities’ solutions” ($B = -0.083$, $SE = 0.027$, $p < .01$) and “states’ solutions” ($B = -0.054$, $SE = 0.026$, $p < .05$).

**Discussion**

Our analysis sought to understand whether US politicians used Twitter to lead on climate change as “trustees,” played to the crowd by following existing opinion, or simply served partisan interest in the extent to which they called attention to climate change as an issue by tweeting about it. Issue ownership (party) was a significant predictor of tweeting behavior; however, we find evidence that politicians within in both parties “play to the crowd.”

This is in contrast to the influence of the estimated real-world impacts on their constituents, that is, the information these politicians would be consulting as trustees. We find no evidence of either Republicans or Democrats basing their volume of discussion about climate change on the risks scientific analysis shows their constituents face. This is perhaps less surprising for Republicans, whose resistance to addressing climate change is partly based on a denial of the science itself (McCright & Dunlap, 2011). However, it holds for Democrats as well. The likelihood of a Democratic politician tweeting about climate change is associated with existing public opinion, but not with the risks faced. In fact, in direct contradiction of the model of elected officials as trustees, we find evidence that politicians representing the areas most at risk are least likely to tweet about climate change, though this effect can be explained by the income level of their constituency, suggesting it may be related to access to resources in their district/community. This finding is not meant to equate Democrats and Republicans on this issue, but only to point out that both appear to be responding to similar political incentives in constructing their social media discourse. Democrats embrace, rather than deny, science, but do so in a way consistent with what their constituents already demand.

### Table 3. Topics on Politicians’ Climate Change Tweets (Ranked by Proportion).

| Topic number | “Topic” and associated words | Label | Proportion (%) |
|--------------|------------------------------|-------|----------------|
| 10           | must act environment threat economy fight health now protect real planet | Calls for action | 16.26           |
| 4            | parisagreement trump potus acton real donald trumps future health defend science must stillin | Trump & Paris Agreement | 11.66           |
| 2            | wildfires energy emissions rising year weather temperatures extreme like acton | California wildfires | 9.77            |
| 5            | solutions bipartisan caucus repcurbelo citizens members work sea security issue | Bipartisan solutions | 9.76            |
| 3            | march epa acton action facts trump science planet energy back | EPA & Climate march | 9.46            |
| 9            | join states solution today washington leaders continue fight action can | States’ solutions | 9.12            |
| 8            | justice accord paris agreement issues withdraw environmental communities repjayapal nation | Climate justice & Paris Agreement | 8.87            |
| 6            | cities mayors todaysfact action city lead chaos c40cities disruption mayor | Cities’ solutions | 8.75            |
| 1            | caucuson solution trump science pruitt trumps national repdonbeyer just scott | Climate Solutions Caucus | 8.46            |
| 7            | denial congress fossil fuel action senwhitehouse get speech industry floor | Criticizing fossil fuel & deniers | 7.90            |

EPA = Environmental Protection Agency.

For each topic, the 10 most probable words are included in the list. The words were ranked based on the probability estimated by the Latent Dirichlet Allocation (LDA) model.
**Table 4. Summary of Linear Regression for Variables Predicting Topic Proportions.**

| Topics                                                                 | Dependent variable |
|------------------------------------------------------------------------|--------------------|
| T1: Climate Solutions Caucus (8.46%)                                    |                    |
| T2: California wildfires (9.77%)                                       |                    |
| T3: EPA & Climate march (9.46%)                                        |                    |
| T4: Trump & Paris Agreement (11.66%)                                    |                    |
| T5: Bipartisan solutions (9.76%)                                       |                    |
| T6: Cities' solutions (8.75%)                                          |                    |
| T7: Criticizing fossil fuel & deniers (7.90%)                           |                    |
| T8: Climate justice & Paris Agreement (8.87%)                           |                    |
| T9: States' solutions (9.12%)                                          |                    |
| T10: Call for action (16.26%)                                          |                    |
| Democratic                                                            |                    |
| -0.001                   | -0.002               | -0.014               | -0.014               | -0.034               | 0.054*               | -0.011             | 0.001             | 0.032             | -0.010             |
| (0.023)                  | (0.027)              | (0.026)              | (0.035)              | (0.040)              | (0.026)              | (0.022)             | (0.027)           | (0.026)           | (0.043)            |
| Concerns                                                              |                    |
| 0.002                   | -0.002               | 0.004                | 0.005                | -0.004              | -0.001              | -0.001              | -0.004              | -0.002             | 0.003              |
| (0.003)                  | (0.003)              | (0.004)              | (0.005)              | (0.005)              | (0.003)              | (0.003)              | (0.003)              | (0.003)           | (0.005)            |
| Income                                                                |                    |
| -0.019*                 | -0.012               | -0.014               | -0.016               | -0.014              | 0.086***             | -0.019*             | -0.016             | 0.011             | 0.012              |
| (0.008)                  | (0.009)              | (0.012)              | (0.014)              | (0.009)              | (0.009)              | (0.007)             | (0.009)             | (0.009)           | (0.015)            |
| State level                                                           |                    |
| 0.031                   | 0.019                | 0.020                | -0.002               | -0.012              | -0.106***            | 0.002               | 0.027              | 0.035              | -0.014             |
| (0.026)                  | (0.031)              | (0.030)              | (0.040)              | (0.045)              | (0.030)              | (0.025)             | (0.031)             | (0.029)           | (0.049)            |
| Federal level                                                        |                    |
| 0.022                   | 0.016                | 0.007                | 0.004                | 0.018               | -0.115***            | 0.014               | 0.035              | 0.010             | -0.011             |
| (0.022)                  | (0.026)              | (0.026)              | (0.034)              | (0.039)              | (0.026)              | (0.021)             | (0.026)             | (0.025)           | (0.042)            |
| Democratic*State                                                   |                    |
| -0.027                  | -0.003               | -0.011               | -0.010               | -0.017              | -0.053               | 0.007               | -0.030              | 0.070*             | 0.040              |
| (0.029)                  | (0.034)              | (0.033)              | (0.044)              | (0.051)              | (0.033)              | (0.027)             | (0.034)             | (0.033)           | (0.054)            |
| Democratic*Federal                                                  |                    |
| -0.016                  | 0.015                | 0.020                | 0.056                | -0.015              | -0.083***            | -0.015              | -0.035              | -0.054*            | 0.127**            |
| (0.023)                  | (0.028)              | (0.027)              | (0.036)              | (0.041)              | (0.027)              | (0.022)             | (0.028)             | (0.026)           | (0.044)            |
| Income*State                                                        |                    |
| 0.005                   | 0.017                | 0.008                | 0.011                | 0.025               | -0.099***            | 0.015               | 0.022              | -0.013             | 0.009              |
| (0.014)                  | (0.016)              | (0.016)              | (0.021)              | (0.024)              | (0.016)              | (0.013)             | (0.016)             | (0.016)           | (0.026)            |
| Income*Federal                                                     |                    |
| 0.025***                | 0.013                | 0.017                | 0.011                | 0.015               | -0.092***            | 0.018*              | 0.007              | -0.015             | 0.002              |
| (0.008)                  | (0.009)              | (0.009)              | (0.012)              | (0.014)              | (0.009)              | (0.008)             | (0.009)             | (0.009)           | (0.015)            |
| Constant                                                             |                    |
| 0.074***                | 0.077***             | 0.085***             | 0.093**              | 0.115**             | 0.198***             | 0.084***            | 0.079**             | 0.086***           | 0.108**            |
| (0.022)                  | (0.026)              | (0.025)              | (0.034)              | (0.038)              | (0.025)              | (0.021)             | (0.026)             | (0.025)           | (0.041)            |

| Observations | 420 | 420 | 420 | 420 | 420 | 420 | 420 | 420 | 420 | 420 |
|--------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

**R²**          | .063 | .045 | .056 | .151 | .097 | .661 | .106 | .157 | .305 | .370 |
**Adjusted R²** | .043 | .024 | .035 | .132 | .077 | .654 | .086 | .138 | .289 | .356 |
**Residual SE (df=410)** | .044 | .051 | .050 | .067 | .076 | .050 | .041 | .052 | .049 | .082 |
**F statistic (df=9,410)** | 3.086** | 2.123* | 2.692** | 8.079*** | 4.878*** | 88.978*** | 5.405*** | 8.454*** | 19.960*** | 26.709*** |

EPA: Environmental Protection Agency.

*p<.05; **p<.01; ***p<.001.

Analysis of the politicians’ scope of responsibilities also reveals significant differences. While federal politicians are more “partisan,” differing more by party than local politicians do, local and state politicians play to the crowd more than federal politicians do. As in our other analyses, we do not see any evidence of a sub-group of politicians (local, state, federal) leading as trustees.

The concrete result of these findings is that politicians’ leadership via social media on this issue is limited. The politicians who call attention to climate change on social media tend to be those with constituents who are already convinced that climate change is important. Most concerningly, there are cases of Republicans with unconcerned citizens who are at high (relative) risk who do not speak up at all (e.g., Rep. Ron DeSantis [R-FL-6]), as well as some Democrats in a similar position (e.g., Senator Claire McCaskill [D-MO]). There are also some geographic areas that face limited (relative) risks due to climate change but where politicians are quite vocal (e.g., Senator Jeff Merkley [D-OR]; Rep. Paul Tonko [D-NY-20]).

Analyzing the content of those who do tweet about climate change, we find that these differences in who speaks also have an impact on the overall stream of what is said about climate change by politicians. Specifically, federal Democrats, and federal politicians representing wealthy constituencies tend to speak about climate change most. These politicians lead the discourse to emphasize “calls for action,” and this topic has the highest volume with topic proportion of 16.26%. Other issues, such as “Climate Solutions Caucus” (8.46%) and “criticizing fossil fuels & deniers” (7.90 %) which have higher volumes among politicians representing lower income districts, are then under-represented. These tendencies may help explain findings by Leiserowitz and colleagues (2018), that Americans regard climate change as a risk to others rather than a risk to themselves.
Implications and Future Directions

In recent years, there has been much concern about the influence of social media on the dissemination of accurate information (Lazer et al., 2018). These concerns mostly focus on the ability to allow individuals to choose unreliable, or even intentionally misleading, sources of information. Less attention has been paid to whether sources of information that are trusted also fail to lead by “omission.” In particular, for issues like climate change, where accurate information is difficult to glean from personal experience (Shao & Goidel, 2016), accurate public perceptions require expert information be spread to the public. In this context, it is not only important that accurate messages be communicated, but trusted speakers select message topics that accurately reflect the most important issues.

Our study suggests that on climate change, there is substantial room for improvement in this regard. In simple terms, politicians in high-risk areas are abrogating their trustee responsibility to inform their constituents about the risks they face. At the same time, politicians whose constituents are already concerned about climate change could make a greater contribution by focusing their efforts on persuading their more reluctant colleagues. Of course, these efforts are not “zero-sum,” a politician can tweet vigorously about a topic—playing to their own crowd—and also work to encourage others to do so. However, our findings indicate that the aspects of the issue highlighted by politicians whose constituents are already concerned about climate change could make a greater contribution by focusing their efforts on persuading their more reluctant colleagues. Of course, these efforts are not “zero-sum,” a politician can tweet vigorously about a topic—playing to their own crowd—and also work to encourage others to do so. However, our findings indicate that the aspects of the issue highlighted by politicians whose constituents are already concerned about climate change are distinct from those chosen by politicians whose constituents need more convincing. Since news media often draw their frames for issues from Twitter (Neuman et al., 2014),  

Figure 1. Significant differences of climate change topics tweeted by politicians. On average across all office levels, Topics 1 and 7 are more likely to be tweeted by politicians representing poorer districts. Topic 6 is more likely to be tweeted by local Democrats, especially those representing wealthier districts. Topic 9 is more likely to be tweeted by Democratic governors. Topic 10 is more likely to be tweeted by federal Democrats.
working to elevate the voices trusted by those who are not yet convinced may be important. On Twitter, one way to elevate these voices is to refrain from drowning them out (He et al., 2017).

Thus, although our findings are consistent with Cody et al. (2015), our conclusions are different somewhat. Cody and colleagues (2015) argue that the dominance of climate change activists (vs. skeptics) on Twitter makes it “a valuable resource for the spread of climate change awareness” (p.1). We would attenuate that claim by noting that while vocal activists are clearly preferable to vocal skeptics, there is value in activists’ finding the voices that are trusted by the audiences that need convincing, rather than that speak to the already convinced.

Future research might evaluate whether similar dynamics apply to politicians’ discussion of COVID-19. That is, it might be useful to analyze who is speaking up more—local or federal politicians—and the extent to which it corresponds to the specific risks faced by constituents at a particular point in time. We also find evidence that another reason that risks may be downplayed is a community’s access to resources, a topic that further research might explore.

Our study has two limitations. The first limitation is about the risk and concern data. The risk dataset is an estimate of projected future risks in distant future (2080–2099). One previous study shows that the uncertain future cost of climate change is an important factor that prevents people from taking significant actions (Weber, 2010). Thus, future research might consider using more recent risk data of climate change to see if the uncertainty is a major reason why politicians do not lead as trustees. Our measures of climate change risks and concerns are not available at the city level and had to be transposed from the county level, which may homogenize variation between them. Future work should consider using direct measures at the city level.

In addition, although we intentionally avoided using politicians’ campaign accounts, some of their tweets might have different incentives when they were sent in-office versus during campaigns. Future studies may explore this difference to see if elections have strong incentives to influence politicians’ communication about climate change.

Conclusion

This study uses geo-located data to examine the roles that politicians play when tweeting about climate change. We found that politicians in both parties tweet about climate change to play to their crowd, even after controlling for the partisan differences. This tendency, combined with a tendency for federal politicians to be more active, leads to an over-emphasis of the voices from federal Democrats. We believe these findings will facilitate the understanding of how politicians engage with climate change and other scientific topics that may also bias the political discourse on social media.

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Supplemental Material

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