Weather, Salience of Climate Change and Congressional Voting

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Abstract

Climate change is a complex long-run phenomenon. The speed and severity with which it is occurring is difficult to observe, complicating the formation of beliefs for individuals. We use Google search intensity data as a proxy for the salience of climate change and examine how search patterns vary with unusual local weather. We find that searches for "climate change" and "global warming" increase with extreme temperatures and unusual lack of snow. Furthermore, we demonstrate that effects of abnormal weather extend beyond search behavior to observable action on environmental issues. We examine the voting records of members of the U.S. Congress from 2004 to 2011 and find that members are more likely to take a pro-environment stance on votes when their home state experiences unusual weather.

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JEL: Q54, Q58, D72

1. Introduction

Anthropogenic climate change is one of the most difficult policy problems that humanity faces today. The costs and benefits of mitigating carbon emissions are highly uncertain. The relevant pollutants are globally mixing, which creates an enormous collective action problem. Finally, the process of climate change unfolds over several decades. Because the impacts of climate change manifest themselves as gradual changes in the distribution

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of weather outcomes, it can be difficult for individuals to observe whether climate change is occurring. In addition, climate change is a one-time event, and individuals cannot possibly draw on prior experience to guide their perceptions. However, public support and understanding are vital to the successful creation and implementation of climate change mitigation and adaptation policies.

Given these complications, people may seek a proxy by which to update their opinion. Unusual weather could be used (rightly or wrongly) as an observable, short-term analog to climate change. Indeed, Hansen et al. [9] describe the effect of climate change as changing the weights on a pair of dice that determine short-run realizations of weather. In this paper, we estimate the effect of unusual weather conditions on salience of climate change. We proxy for salience using a search intensity index created by Google for the terms "climate change" and "global warming". Controlling for a wide variety of fixed effects to account for spurious geographic and seasonal relationships and broad temporal trends, our results are remarkably robust and suggest that short-run weather phenomena do in fact affect the extent to which people think about climate change.

Furthermore, we demonstrate that the effects of weather extend beyond search behavior to the voting records of U.S. Congressional members. Examining *within-member* variation in support for 207 environmental votes tracked by the League of Conservation Voters (LCV) between 2004 and 2011, we find evidence that voting on environmental issues is correlated with recent unusual weather in a representative's home state. Reassuringly, the correlation between weather and voting does not extend to votes unrelated to the environment. Although the effect is modest in size, our results suggest that that search intensity may provide a useful proxy for voter and legislator concerns and demonstrates an important link between unusual weather and political action on environmental policy.

Our work relates to several other papers. A series of papers estimate the extent to which individuals respond to short-run weather in forming their beliefs about climate change. Deryugina [5] uses an annual Gallup poll to determine whether individuals respond to weather fluctuations by Bayesian updating their expectations about climate change. She finds that while short-term weather fluctuations do not affect individuals' beliefs, longer spells of unusually warm weather do have an impact. She also examines heterogeneity by political affiliation and finds that the effect is confined largely to conservative respondents. Hamilton and Stampone [8] analyze a series of polls of New Hampshire residents. Interestingly, they find that political independents are the only subgroup that respond to recent weather cues in forming their opinions regarding climate change. Owen et al. [16] find that respondents to a pair of surveys in August 2009 and October 2007 are more likely to support environmentally-protective policy if their state experienced a heat wave or drought during the most recent summer. They also find that people who regularly access more sources of news information are less responsive to weather cues. Egan and Mullin [7] also find evidence of a response.

A separate literature demonstrates the value of internet search data in modeling economic behavior. Choi and Varian [4] demonstrate that Google Insights data can be used to predict demand for automobiles, retail sales, home sales, and travel behavior. After several papers demonstrated the efficacy of using Google searches to predict flu outbreaks, Google itself established the Google Flu Trends tool.[1] Most relevant to our analysis is Kahn and Kotchen [12]. They find that when a state's unemployment rate increases, Google search activity for "global warming" decreases and search activity for "unemployment" increases. That is, concerns about economic conditions "crowd out" attention to the issue of climate change. These results focus on unrelated trends that compete with climate change for attention. In contrast, we examine a factor (weather) that *directly attracts* attention to climate change because it is a series of realizations of the broader climate process.

Our paper makes two contributions. Previous studies of climate beliefs and weather use survey waves that are either infrequent or limited to a specific geographic location. In contrast, search intensity is reported weekly for each state – higher frequency reporting provides us much more identifying variation with which to estimate the relationship between weather and search intensity flexibly and to better control for unobserved heterogeneity that might be correlated with both weather and search activity.

Our empirical results suggest this flexibility is important along several dimensions. First, the variation in the data allows us to simultaneously estimate the effects of temperature, precipitation and snowfall. For instance, given a response to an unusually warm winter, we can estimate the relative contributions of warmer-than-average temperatures separately from the effect of a lack of snow. These various channels may have completely different implications. For example, if the response is entirely due to lack of snow

[1]http://www.google.org/flutrends

and not higher temperatures, this could limit the relevant geographic (and climatic) range to that in which snowfall now regularly occurs. Further, snowfalls are easily-observed individual events; in contrast, an increased frequency of extreme temperatures might not be as discernible. Second, we find evidence that the search intensity responds asymmetrically to unusually high and low temperatures and snowfall. For instance, in the winter, unusually cold and warm weather are both correlated with increased search; this would be obscured by a fully-linear specification. Third, the effects of weather on search intensity vary by season.

Our second contribution to is to provide an important link between weather and search behavior to observable actions related to the environment – specifically, the voting behavior of members of the U.S. Congress on environmental bills. Previous work has focused on individual attitudes as the explanatory variable of interest, but has not established a link between weather and tangible changes in behavior. Our work helps to fill an important gap. Controlling for member fixed effects, we find that U.S. congressional members are more likely to cast a pro-environment vote when their home state experiences unusual weather and search intensity in their home state is high. Reassuringly, the effects are specific to environmental legislation, and in particular, environmental regulation most closely related to climate change – we do not find similar effects of weather or search intensity on non-environmental legislation, nor do we find strong effects for environmental legislation unrelated to climate policy or industrial emissions. Although the effects we estimate are modest in size (as would be expected) and may not affect the ultimate outcome of the vote, our results suggest that extreme local weather (or the issue salience it generates) is a factor legislators may consider when voting on environmental issues. Furthermore, our results suggest that internet search intensity may provide a useful proxy for the salience of issues to the broader public.

Our paper proceeds as follows. Section 2 describes the data and econometric approach. Section 3 presents the empirical results related to weather and search intensity. Finally, Section 4 examines the relationship between extreme weather, individual search behavior and voting of members of Congress on environmental issues. In the online appendix, we demonstrate the robustness of our results to a number of different specifications.

2. Methodology

2.1. Data

Search intensity data. Our proxy for climate change salience uses the Google Insights (now part of Google Trends) search index. This tool is outlined in Stephens-Davidowitz [18]. Essentially, Google Insights tracks the relative frequency with which a given search term is submitted. In most of our specifications, we use the index for searches of ("global warming"+"climate change") at the state-week level. The index is constructed to facilitate accurate comparisons across periods and locations; that is, a given search term is scaled by the overall level of search activity in each state. The advantage of this approach is that a populous state, such as California, will not have a mechanically higher search index than a less populous state, such as Iowa. Thus, our measure of the search term corresponds to search intensity, conditional on overall search activity. Google censors search terms that do not surpass a certain threshold in terms of *absolute* search volume. This affects approximately 20% of our sample from 2004-2011, but is most relevant in 2004-2006 for sparsely populated states in the Great Plains and Rocky Mountain regions.[2]

We can use several data sources to get a sense of nationwide search magnitudes during our study period. Google Adwords, a service for potential advertisers, reports that U.S. users googled "climate change" or "global warming" approximately 185,000 time per month in 2013. To estimate total search volumes for our study period, we adjust total searches in 2013 for changes in search intensity (tracked by Google Trends) and changes in nationwide Google search volumes from comScore, a market research company that tracks media and internet trends. Although total Google searches rose from 134 billion searches in 2011 to 154 billion searches in 2013, search intensity for "climate change" and "global warming" fell by approximately 20 percent during the period. The two changes roughly offset each other - our best guess is that relevant searches averaged roughly two hundred thousand per month in 2011. Using a similar methodology, we estimate that at the peak, searches for the two terms averaged approximately half-a-million searches in January and February of 2007.

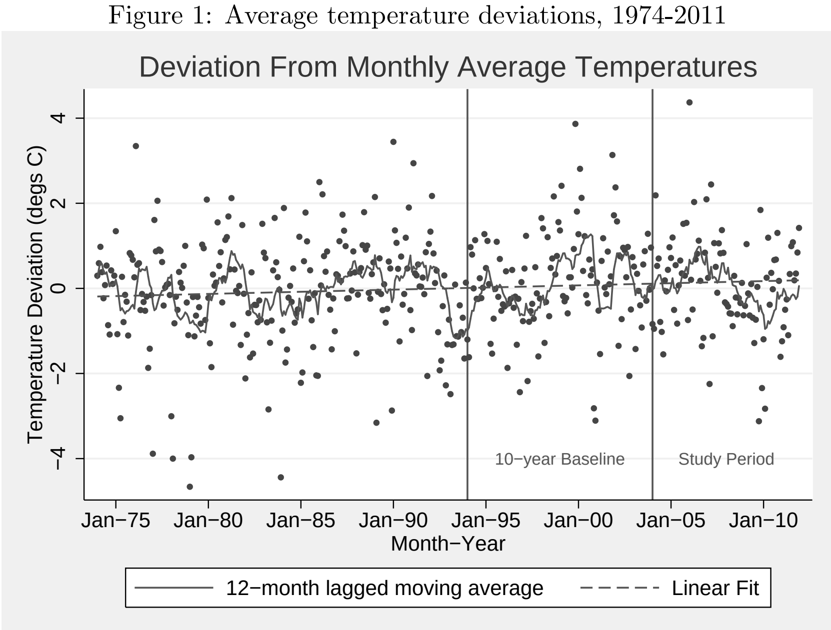
Weather data. Our weather data come from the National Climatic Data Center (NCDC). The NCDC collects daily weather station data for over

[2] In the online appendix, we re-run our regressions using only state-years for which complete data is available and find that our results do not change substantively.

10,000 U.S. weather stations. The typical station records minimum and maximum daily temperature, precipitation and in some cases, snowfall, snow depth and other meteorologic variables. For purposes of this paper, we limit our analysis to 6,624 stations with data on minimum and maximum temperatures from 2004 to 2011. The stations are located throughout the 50 states – Rhode Island has the fewest stations (8) and California, the most (370). For each daily station record, we calculate the deviation of maximum daily temperature, precipitation, snowfall and snow depth from a 10-year baseline from 1994 to 2003 and matched by day of the year. To match the search intensity data, we aggregate up to the state-week level.

Summary Statistics. To illustrate one dimension of our weather variation, we plot monthly average temperature deviations from the 1994-2003 baseline in Figure 1 going back to 1974. The solid line is the lagged 12-month moving average deviation. The dotted line is a linear trend and illustrates that temperatures have been increasing on average since 1974. This trend is less pronounced if we focus solely on the last two decades. Although average temperatures have risen since 1974, the warmest 12-month period in U.S. history prior to 2012 stretched from late-1999 to late-2000, during our 10-year baseline period. We present summary statistics of the weather and

Figure 1: Average temperature deviations, 1974-2011



search variables for our regression sample in Table 1. The weather variables are presented as deviations from the 10-year baseline covering 1994-2003, matched by state-calendar week. Relative to baseline, the period from 2004 through 2011 was similar in terms of temperature and slightly snowier, on average. As one would expect, there is substantial week-to-week variation around the baseline.

The relationship between our sample and the baseline differs by season. Relative to the 10-year baseline, winter has been slightly colder than normal, while spring, summer, and fall have been slightly warmer. The standard deviation of the temperature variable is of the same order of magnitude for all seasons, and suggests that there is considerable variation around the mean. As one would expect, snowfall and snow depth are most variable in the winter, somewhat less variable in the spring and fall, and quite tightly distributed in the summer.

2.2. Empirical Approach

In essence, we want to identify the effect of unusual short-run weather on the relevance of climate change in the eye of the general public, using the Google search intensity index outlined above as a proxy for salience. We take a largely agnostic stance on the mechanisms underlying a possible relationship. Weather could affect search intensity through channels such as personal experience, exposure to news coverage of extreme weather, or interactions with friends and family.

We simultaneously estimate effects for the maximum temperature, precipitation, snowfall, and snow depth. Table 2 presents basic correlations among the explanatory variables. As one would expect, deviations in temperature, snowfall, and snow depth are correlated with one another. However, the frequency of our panel provides sufficient independent variation to estimate the coefficients on each precisely.

The base specification for state s, week w, month m, year y can be expressed as:

$$INDEX_{swmy} = \sum_j \beta_j DEV_{j,swmy} + \alpha_{my} + \gamma_{sm} + \varepsilon_{swmy} \tag{1}$$

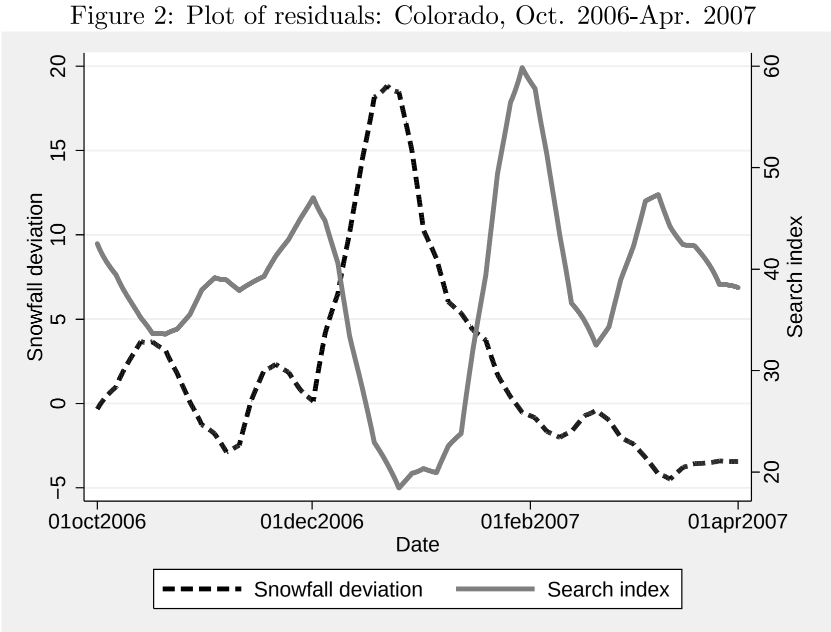
where j indexes the four weather variables, $DEV_{j,swmy}$ is the deviation from the historical mean for measure j, β_j is the effect of measure j on the climate change search intensity index, and α_{ym} and γ_{sm} are fixed effects. In our main specification, we relax the linearity of the relationship of the index on the deviation variables by allowing for asymmetric effects depending on the sign of the deviation:

$$INDEX_{swmy} = \sum_j \beta_j^- DEV_{j,swmy}^- + \sum_j \beta_j^+ DEV_{j,swmy}^+ + \alpha_{my} + \gamma_{sm} + \varepsilon_{swmy} \quad (2)$$

where $DEV_j^- = I(DEV_j < 0) * |DEV_j|$ and $DEV_j^+ = I(DEV_j > 0) * |DEV_j|$. Thus, the coefficients $\{\beta_j^-, \beta_j^+\}$ are the effects of the *magnitude* of negative and positive deviations from the 10-year weather baseline on search intensity.

We graphically illustrate the basic idea behind our empirical strategy. Figure 2 plots kernel-smoothed time trends of the residuals of search index and average snowfall for Colorado from October 2006 through April 2007 after conditioning on year-month and state-month of year fixed effects. Through early December, snowfall tracks close to the 10-year baseline. In late December, relative search activity is halved during a series of weeks with unusually high snowfall. However, as snowfall becomes more scarce in late January and February, search activity increases again. A first

Figure 2: Plot of residuals: Colorado, Oct. 2006-Apr. 2007



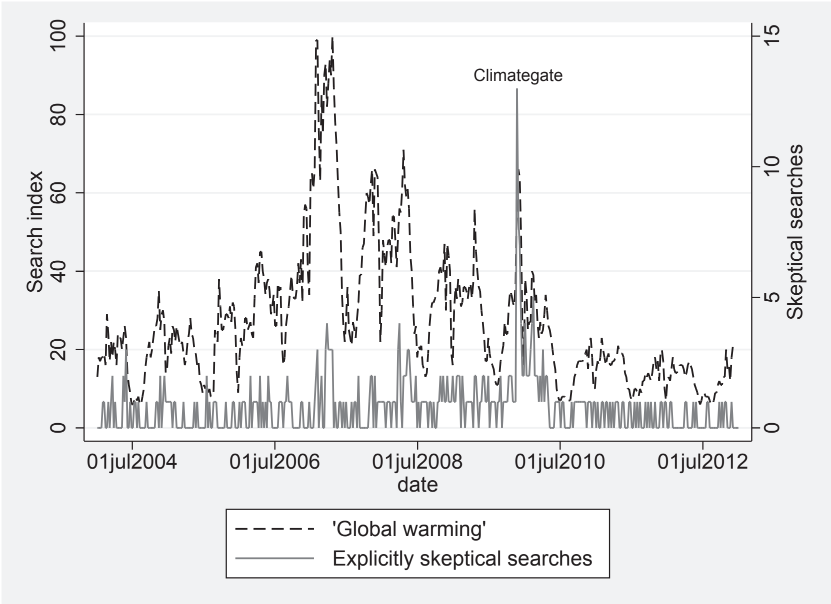
potential concern with our analysis that Google searchers may not be representative of the general public. Past analyses such as Choi and Varian [4] and Kahn and Kotchen [12] suggest that Google search is sufficiently in the mainstream to be useful for this sort of analysis. In addition, we are not making claims as to whether local weather will help support for climate change reach some crucial electoral threshold. Rather, we examine whether very short-run weather events have the capability to affect the salience and prominence of climate change. Compared with 2010 Census data, the distribution of Google searchers skews away from those over 65 years of age, and toward those 18-25. The shares in the 25-44 and 45-65 age groups are roughly the same as in the population.[3]

In addition, one might be concerned that there may be underlying seasonal or geographic correlations that are purely coincidental. For instance, as displayed in Table 1, recent summers have been hot compared with baseline means while recent winters have not. During our sample period, the Conference of the Parties to the United Nations Framework Convention on Climate Change convened during November and December in each year. If this highly climate-relevant event results in a spike in news coverage and search activity, we would incorrectly estimate a negative relationship between maximum temperature and climate search intensity. Similarly, if states with more urban areas have had systematically different weather deviations than more rural states, we might misattribute a correlation between weather differences and differences in political ideology as reflected in interest in climate change.

To address these concerns, we employ a variety of fixed effects to control for such possible sources of bias. In our preferred specification, we include year-month fixed effects and state-month of year fixed effects. The variation identifying our primary estimates controls for broad national trends during a given month, and monthly seasonality at the state level. For a given January week in Iowa, we consider the covariance in how unusual search and weather are among all January weeks in Iowa, controlling for nationwide means in that specific month. The year-month effects capture changes in nationwide attitudes toward climate change, average internet penetration, and changes in the makeup of internet users over time. The state-month of year effects control for state-specific seasonality in weather deviations and climate change search intensity. Finally, search activity by

[3]Google search demographics and age distribution reported by comScore (Source: http://blog.pmdigital.com/2010/08/who-uses-google-yahoo-and-bing) compared to age distribution from 2010 U.S. Census.

Figure 3: All climate-related searches compared to skeptical searches



climate skeptics could affect the implications of our results. In Figure 3, we compare the national time-series of our primary search with one that nets out several potential skeptical searches. As is clear from the figure, these explicitly skeptical searches comprise a small fraction of the total searches. The window indicated in the figure does display one week of particularly high skeptical search activity: it corresponds to the "Climategate" incident. Our results are robust to omitting this period. Of course, we cannot hope to identify all such searches; there exists a strong current of skepticism among parts of the U.S. population. Our results do encompass the causal effect of weather shocks on the search habits of such skeptics. However, our interpretation of changes in search intensity as a proxy for issue salience does not change.

3. Weather and Search Intensity Results

The results from the base specification are presented in Panel A of Table 3. The first column is a simple specification in which climate-related search intensity is modeled as a linear function of deviations from historical weather patterns. Perhaps surprisingly, in the aggregate, higher temperatures (relative to the baseline) are associated with lower search intensity.

The coefficient on snowfall is as expected, in that unusually low snowfall is related to more climate change searches.

We relax the initial specification in two ways. First, we run our analysis separately for each season of the year in columns (2) through (5) of Panel A. This allows the effects of unusual weather on search intensity to have different magnitudes and signs across seasons. For example, unusually warm weather in the winter might be far more noticeable in the winter than in the spring. We find that the effects vary considerably by season. While lower temperatures are still negatively related to search in the winter, the opposite is true in the summer. The effect of unusually low snow depth is now statistically significant in the winter and fall, but not in the spring (or summer).[4]

Second, we allow the effect of weather to vary asymmetrically with respect to positive and negative deviations from the 10-year baseline. Although results from Panel A of Table 3 provide evidence that short-run weather shocks are correlated with search intensity, if search intensity responds differently to positive and negative deviations from the baseline, these specifications may mask the true effect. The bias would be particularly pronounced if search intensity is a function of the absolute deviation of weather from the long run average. To this end, Panel B of Table 3 presents results that allow positive and negative weather deviations to have asymmetric linear effects on search intensity. To be clear, our specification regresses search intensity on the absolute value of positive and negative deviations. If the coefficients for the positive and the negative deviation in snowfall are both positive, then the relationship between snowfall and search intensity is "V"-shaped.

Both positive and negative deviations from the baseline average temperature are positively associated with search intensity. The negative temperature deviation coefficient from column (1) of Panel A is driven by the fact that the search-inducing effect of a negative deviation dominates the effect of a positive deviation. Search intensity seems to respond weakly to unusually dry weather. The coefficients on snowfall and snow depth especially illustrate the importance of allowing for asymmetric effects. The negative snowfall and snow depth coefficients from column (1) of Panel A would suggest that there is more search activity in normal weeks than in especially

[4]For completeness, we also present coefficients for each month of the year in the online appendix. Providing further flexibility in estimate the coefficients by month does not provide any additional insights beyond the estimation by season.

snowy weeks. However, when we allow asymmetric effects, we find that weeks of abundant snowfall and snow depth do not seem to differ from a normal week in terms of search intensity. Instead, the flexible specification demonstrates that the effect in Panel A is driven by weeks with a notable lack of snow. The coefficients on negative deviations in snowfall and snow depth are roughly four times larger than their counterparts in Panel A, and the coefficient on snow depth is now statistically significant.

We again run separate regressions for each season and present the results in columns (2) through (5) of Panel B. We interpret the magnitude of the coefficients in the following manner. The search index is simply the number of searches involving climate change or global warming as a share of total search activity, scaled by some unknown coefficient. We assume that climate-related searches are a small proportion of total search activity. Thus, a 10% increase in the search index corresponds to a 10% increase in climate-related searches. We will consider the effect of weather shocks on the mean week in percentage terms. For instance, in the winter, the mean search index is 43.02. An 4.302-unit increase in the search index during the winter would correspond to a 10% increase in climate-related search over the mean week.

As before, we find substantial variation in the effect of abnormal weather across seasons. In the winter, search intensity responds positively to both unusually cold and warm weather. In particular, a winter week that is 4°C colder than normal (1 standard deviation of our temperature variable) would result in an increase in the search index of 6.54, or a 15.2% increase in climate-related search activity relative to the mean week. Similarly, a week that is 4°C warmer than normal would result in an increase in the search index of 2.20, or about 5.1%. Much of the effect of warm winter weather operates through a lack of snowfall. Indeed, a winter week that has less snowfall than average by only 10mm (roughly 1 standard deviation) is also associated with an increase of roughly 2.56 (6.0%) in the search index; a week in which the average snow depth is lower than usual by 1 standard deviation (roughly 70mm each day) is associated with an increase of 5.32 (12.4%) in the search intensity. These magnitudes suggest that weather shocks are actually responsible for fairly large movements in climate-related search activity relative to the mean week.

Responses during other seasons demonstrate different patterns. In the spring, weather does not actually seem to have much of an impact: none of the coefficients are statistically significant. This confirms a main result of Deryugina [5], who finds that beliefs elicited in a March survey are not affected by very short-run weather deviations. In the summer, search responds strongly to extremely hot temperatures, but not to cool temperatures. Negative deviations in summer precipitation are associated with less search. Finally, in the fall search increases with unusually low snowfall and snow depth. This is consistent with search responding to steadily warm fall weather that delays the first snowfall or a heat wave that results in unexpectedly extreme temperatures.

In the online appendix, we provide a number of robustness checks. We run separate regressions for each month of the year. We also repeat our analysis including several different of combinations of fixed effects. Finally, we perform our analysis at the city level for the 25 largest cities in the U.S. Our results prove to be quite robust to all of these alternative specifications.

It is important to note that these results are consistent with several alternative models of economic behavior and belief updating. Despite the high temporal frequency, the aggregate nature of the search data does not allow us to make strong conclusions about the particular method by which people adjust their beliefs. As an example, our results may reflect rational re-evaluation of beliefs of climate change by individuals who were previously skeptical. Unusual weather may cause them to update their beliefs and search online for more information about climate change.[5] Equally plausible, though, are alternative explanations for relationship between unusual weather and search activity. Evidence in favor of some of these explanations already exists in the literature. Kahn and Kotchen (2010), for example, propose that concerns about environmental concerns fight for individuals' limited attention - they find evidence that concerns about climate change may be crowded out by economic concerns. More generally, we think it unlikely that a single explanation would fully explain the relationship between abnormal weather and search behavior. Thus, we refrain from advancing a particular story or explanation for the results, although we believe that this is an interesting avenue for future research.

[5]If we believe, though, that this is the only driver of search activity and that there is an initial stock of "climate skeptics," we might expect that stock to deplete over time and more unusual weather occurs and consequently, the effect of unusual weather may diminish. In our data, we do not find strong statistical evidence that the effects of unusual weather on search behavior diminish over time, although we acknowledge that this does not provide definitive evidence against this explanation.

4. Weather, Search Intensity and Voting Behavior

We now pivot from examining the relationship between abnormal weather and internet search activity to examining observable action on environmental issues, specifically the voting behavior of members of the U.S. Congress. In this section, we extend our approach from the previous section demonstrate that atypical weather is correlated with the voting behavior of members of the U.S. Congress on environmental issues.

Our analysis directly relates to two literatures. A long literature in political science suggests "issue salience" plays an important role in voter engagement [1], attitudes towards elected officials [6] and policymaking [2]. Specifically, issues which voters perceive as particularly relevant are correlated with election turnout, approval ratings and political action on issues. Second, our results relate to the literature on classic political economy originating with Stigler [19] and Peltzman [17] that postulate that voting behavior is driven both by individual ideology and the need to represent constituent interests.

Our primary source of voting data comes from the League of Conservation Voter ("LCV") scorecards. For each member of Congress and each vote on bills, resolutions, motions and amendments related to the environment, the LCV records a member's vote and identifies whether the vote represents a pro- or anti-environment position. LCV scorecards (and voting scorecards more generally) have been used extensively in the literature [see 11, 14, 13] to identify members of Congress who tend to take pro- or anti-environmental stances. For our analysis, we use constructed a panel of all the members of the U.S. House of Representative or the U.S. Senate. For each congressperson, we track his or her vote on 207 environmental votes scored by the LCV between 2004 and 2011.[6] Democrats tend to receive high LCV ratings and Republicans tend to receive low LCV ratings – the mean ratings for Democrats and Republicans are 89.7 and 14.1 on a scale of 0 (uniform voting against environmental positions) to 100 (uniform voting in favor of environmental positions), but LCV scores vary within political party substantially. Of congressional members in office for more than a single year in the 2004-2011 period, Dan Boren (House, OK) was the lowest

[6] We exclude eight votes that are tracked by the LCV, but not directly related to environmental issues, such as the reauthorization of the Childrens' Health Insurance Program or the nomination of federal judges. Our results are robust to the inclusion of these six votes.

rated Democrat at 32.7 and Christopher Shays (House, CT) was the highest rated Republican at 88.1.

We consider a linear probability model and regress pro-environment voting as a function of weather in a member's home state.[7] All specifications include congressional member fixed effects. Consequently, identification comes from within-member variation – we test whether member i's vote on environmental vote v is correlated with anomalous weather conditions in their home state s at a similar point in time t. We also include varying sets of time fixed effects to flexibly control for state-invariant shifts in the propensity to vote in favor of environmental regulation.

We use two approaches to test for the relationship between anomalous weather and congressional voting. First, we directly regress voting on the weather variables from the previous section. As before, we allow for an asymmetric relationship between the dependent variable and positive and negative weather deviations. Formally, our we consider the specification

$$Pro - Env.\ Vote_{iv} = \alpha_i + \sum_j \beta_j^- DEV_{j,st}^- + \sum_j \beta_j^+ DEV_{j,st}^+ + \varepsilon_{iv} \qquad (3)$$

where j denotes each weather variable and $DEV_{j,st}^-$ and $DEV_{j,st}^+$ represent negative and positive deviations from the 10-year baseline.

Table 4 presents the main results relating voting on environmental issues to weather and search intensity. Panel A presents the results of the linear probability model of pro-environment voting on weather, member fixed effects and successive sets of time fixed effects. Unusually low temperatures in a member's home state are correlated with a greater likelihood of voting against environmental legislation or motions. Unusually low snowfall in a member's home state is correlated with an increased likelihood of voting in favor. The magnitudes are modest but significant and persist with the inclusion of year-month fixed effects that subsume the effect of national weather or news spuriously correlated with weather that occurs in the month of the environmental vote. Snowfall one standard deviation below the mean during winter months in associated with an 1.5 percentage point increase in the likelihood of voting in favor of environmental legislation. The eight weather variables are highly significant, collectively, in the specifications in columns (1) and (2). In the specification in column (3), the p-value on the F-test of the weather variables is 0.147, slightly above conventional levels

[7]We obtain qualitatively similar results using a probit model.

for significance.

As a second approach, we construct an "index" of the abnormality of recent weather in a state. For our index, we project search intensity onto four lags of the local climate deviations for temperature, precipitation, snowfall and snow depth.[8]

In essence, the projection consolidates unusual rainfall, temperatures and snowfall into a single summary statistic. This procedure creates a more parsimonious measure of abnormal weather; we use this measure to clarify the relationship with voting behavior and allow heterogeneity to enter in a concise way. As a result, we interpret the coefficient on the projected weather variables as the reduced-form effect of any combination of collectively abnormal weather variables that would induce a one-point change in search intensity.

It is important to note that the interpretation of the coefficient in this context differs from that of an instrumental variable regression. A true IV regression would estimate the causal effect of one particular channel (in our case, search intensity) on voting. Rather, our approach measures the collective effect of weather through a number of different channels. The projection allows us to treat unusual realizations of temperature, precipitation and snowfall comparably.

Our approach is similar to a number of recent papers that project one or more covariates onto a single variable to analyze a reduced-form effect. Madestam et al. [15] examine political protests and representative voting. They project the size of Tea Party tax day protests on rainfall but cautiously interpret the coefficient on protest size, noting that rainfall may affect both the size of the protest and "quality" of the protest. Chodorow-Reich [3] compares post-financial crisis employment at firms as a function of the exposure of a firms' banking partners to the financial crisis. As a proxy for a bank's exposure, the paper projects the change in annualized loans between 2005 and 2009 onto a set of pre-crisis covariates plausibly related to a bank's financial strength. Again, the author notes that the "second stage" does not identify a particular causal pathway. Rather, the projected change in annualized loans is interpreted as a summary statistic for a number of factors related to the financial strength of the bank.

A second advantage of the projection of search intensity onto the weather variables is to mitigate concerns of reverse causality. If internet searches

[8]The F-statistic for the joint test of the coefficients on the weather variables in equation (4) is 26.53.

related to climate change are partially driven by actions taken by Congress or by the voting of particular members, a positive correlation between search intensity and Congressional voting may simply reflect constituents' interest in the position taken by their representative. In contrast, the projection only relies on variation in search intensity correlated with lagged weather variables.

Formally, we estimate the following:

$$SI_{st} = \gamma_s + \sum_{k=1}^{4} \sum_{j} \lambda_{jk}^{-} DEV_{js,t-k}^{-} + \sum_{k=1}^{4} \sum_{j} \lambda_{jk}^{+} DEV_{js,t-k}^{+} + \nu_{st} \quad (4)$$

$$Pro - Env.\ Vote_{iv} = \alpha_i + \beta \widehat{SI}_{st} + \varepsilon_{iv} \quad (5)$$

In Panel B, we present the coefficients estimated by (5), using member fixed effects and a similar series of time fixed effects to those in Panel A. [9] Again, we find that the weather-correlated component of search intensity is correlated with voting in favor of environmental legislation – a one standard deviation increase in scaled search intensity (.28) is associated with a 8.4 percentage point increase in the likelihood of voting in favor of environmental legislation. As with the weather variables, the magnitude of the coefficient declines with the inclusion of finer time fixed effects. Month by year fixed effects subsume the effect of national weather events, such as the 2012 U.S. summer heatwave. Identifying the coefficient off of this within-month variation only, a one standard deviation increase in search intensity is associated with a 2.3 percentage point increase in the likelihood of voting in favor of environmental legislation. As a point of reference, Hussain and Laband [10] examine 33 LCV votes whose costs are confined to a small set of states. Senators who represent one of those states are 15% less likely to cast a pro-environment vote. Given the extreme political circumstances involved in those votes, our effect (one-eighth as large for a 1 standard deviation increase in search, one-quarter as large for a 2 standard deviation increase in search) appears non-negligible.

While we find evidence of a strong positive correlation between weather-driven search intensity and likelihood of pro-environmental voting, as we note able we are not interpreting the regression results above as an IV estimate of the causal effect of search intensity on voting behavior. Rather,

[9] For ease of presentation, we rescale the Google Search Intensity a scores by a factor of 100 - values of 0 and 100 in the original index correspond to values of 0 and 1 in the rescaled index.

there are several possible pathways that could be driving this correlation. First, the weather might directly affect the Congressperson's ideology/beliefs in the same way that it affects his/her constituents' beliefs. Second, the weather might directly affect voting through Congressional beliefs, thus leading to increased search through increased constituent awareness or local media coverage. Third, the increased search activity could indicate increased constituent pressure on the Congressperson to vote in an environmentally-favorable way. Our data do not allow us to distinguish among these three effects, but they are all relevant in that they reflect an impact (whether direct or indirect) of weather shocks on legislative behavior.

One concern with these results is that the timing of votes may be endogenous. All of our previous results condition on an environmental vote being held – for endogeneity to spuriously drive our results, Congress would have to schedule favored environmental votes in weeks following extreme weather and unfavored environmental votes in other weeks. Because we only include year-month and member fixed effects, our identification strategy would be vulnerable to such a phenomenon. Although we cannot observe whether a particular environmental vote is preferred for other reasons, we can examine whether the timing of environmental votes seems to follow extreme weather overall. We regress contemporaneous and one-week lagged weather deviations on an indicator for whether an LCV vote occurred, controlling for year-month and state fixed effects. The idea is to compare weeks within a calendar month, and see if LCV votes happen following weeks with more extreme weather. We do not find evidence that this is the case. Given this finding, reverse causality would only be problematic if those environmental votes that are inherently more favored overall also tend to be scheduled after especially extreme weeks of weather.

A second concern is other factors that might drive a spurious relationship between the timing of votes and unusual weather. It is still possible that local weather is spuriously correlated with changing political preferences at the state-level and hence, within-member voting on environmental legislation. As a placebo test, we examine voting data from the American Conservative Union (ACU). Similar to the LCV, the ACU tracks "a wide range of issues before Congress to determine which issues and votes serve as a dividing line to help separate those members of the U.S. House and Senate who protect liberty as conservatives and those who are truly liberal."[10] For the placebo test, we use the 350 non-environmental votes tracked by

[10]Source: http://conservative.org/legislative-ratings/

the ACU from 2004 to 2011.[11] If general political preferences are shifting at the same time as unusual weather, we should expect that the weather-correlated variation in search intensity would be correlated with voting on non-environmental votes tracked by the ACU. Table 5 presents the results of an identical specification to Panel B of Table 4 using Congressional member voting on non-environmental issues tracked by the ACU rather than environmental votes tracked by the LCV. Columns (1) through (3) use all of the non-environmental votes tracked by the ACU; columns (4) through (6) use only the non-environmental votes tracked by the ACU that occur in the *same week* as the environmental votes tracked by the LCV. We do not find the weather-correlated component of search intensity to be strongly correlated with taking liberal or conservative positions on votes unrelated to the environment, even when restricting the set of votes to those occurring in the same week as the LCV votes. Thus, we do not find strong evidence that suggests that our results are driven by changes in *general* voter preferences that are spuriously correlated with unusual weather.

Finally, we consider two possible sources of heterogeneity in the response of voting to unusual weather, drawing on the political economy literature originating with Stigler [19] and Peltzman [17] that postulate that voting behavior is driven both by individual ideology and the need to represent constituent interests. Similar to more recent empirical articles on voting behavior, such as Kalt and Zupan [13] and Levitt [14], we posit that the weight a representative places on individual ideology and constituent interests vary with respect to the position of the representative and the nature of the issue on which the vote is taken. For example, incumbents facing re-election may weight constituent interests highly as might a representative facing a vote that demonstrates dedication to his or her district.

In our context, we examine two sources of heterogeneity. First, we allow the response to extreme weather to vary by congressional member characteristics. If left-leaning constituents care more about environmental issues, we posit that representatives from these districts may face greater pressure in response to abnormal weather. Moreover, we might expect that representatives facing 2-year re-election cycles in small, geographically con-

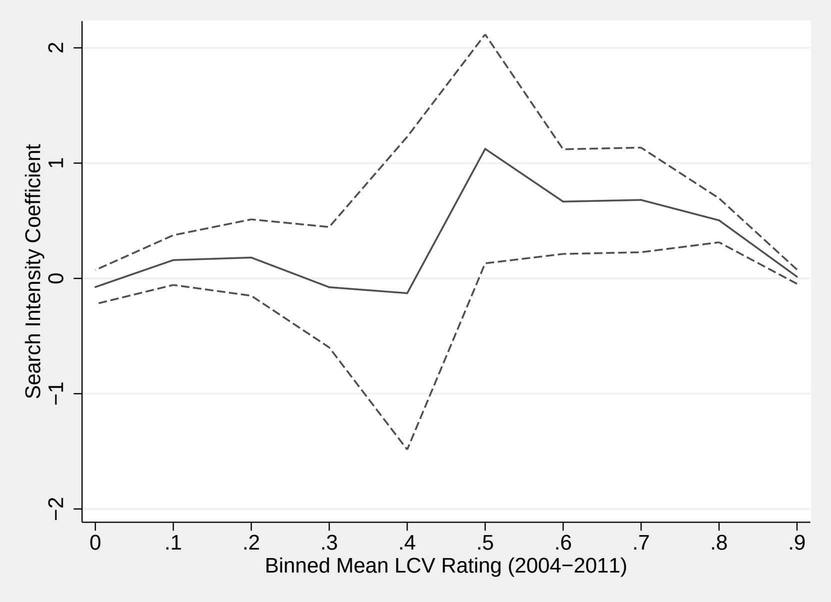
[11] The ACU tracks votes related to immigration, the minimum wage, family planning, religious freedom and other issues unrelated to the environment. In addition, the ACU tracks 44 votes related to the environment issues that are also tracked by the LCV (e.g. HR 2643: Allowing the Dept. of the Interior to issue new leases for offshore natural gas development); we omit these 44 votes from the placebo test.

tained districts may face greater re-election pressure from constituents than senators and consequently, may be more responsive to short-lived weather anomalies.

The specifications in Table 6 test whether the strength of the correlation between search intensity and voting behavior differs by the characteristics of the Congressional member. We interact the weather-correlated component of search intensity with whether the member of Congress is a Democrat, a member of the Senate, and with the member's LCV score over the 2004-2011 period. In one of the three specifications, we find that the correlation between anomalous weather in a member's home state and voting on environmental legislation is significantly stronger in the House than the Senate. This is consistent with the hypothesis that six-year terms in the Senate that may make Senators less responsive to short-lived changes in constituent interests. We also find strong evidence that the response to unusual weather also differs by political affiliation. The correlation between voting and home-state search intensity is significantly stronger for Democrats than Republicans. As a refinement, we allow for the response to unusual weather to differ for each ten-percentage point bins of LCV ratings. These coefficients are plotted with 95% confidence intervals in Figure 4.[12] As before, positive values indicate that a member is more likely to take a pro-environment stance when home-state search intensity is high and less likely to take a pro-environment stance when home-state search intensity is low. Although we find little evidence of correlation between voting and home-state search intensity for members with LCV ratings below 50 percent, we find a positive and strongly significant relationship for members that take a pro-environment stance slightly more than half the time. Unsurprisingly, the correlation diminishes for members with very high LCV ratings – these members almost always vote in favor of environment legislation. A second source of heterogeneity examines the characteristics of the votes themselves. The LCV tracks a wide variety of votes related to the environment, only a subset of which relate to climate change or air pollution more generally. If a congressional member's vote acts as a verifiable signal to constituents, we might expect the effect of unusual weather to be greater for policies that directly relate to climate change or pollution. To test this hypothesis, we hand-classify the 207 votes into three categories: (1) 18 votes directly related to climate change or carbon policy, (2) 84 votes

[12]The specification generating the coefficients estimates in the figure is a refinement of specification (3), and includes member fixed effects.

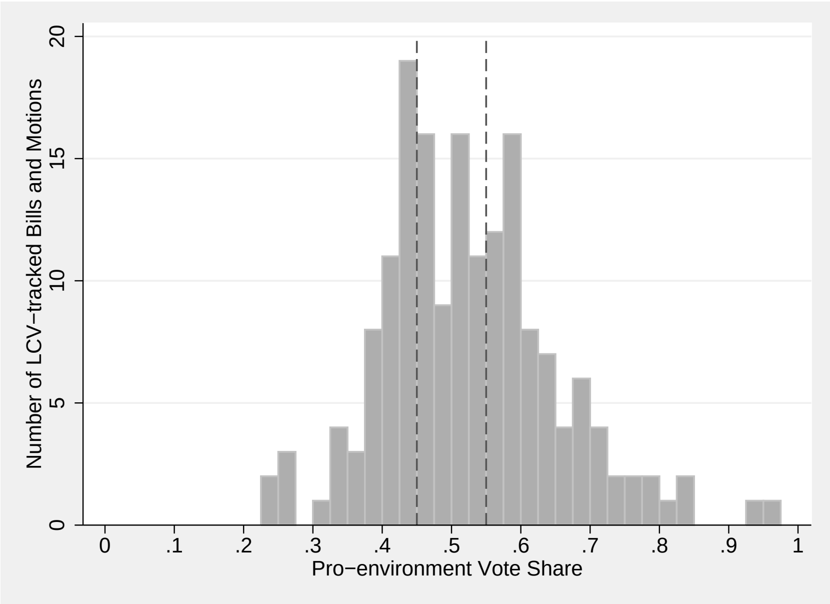
Figure 4: Estimated effect of search on voting by member's overall LCV score



related to industrial pollution or regulation, and (3) 105 votes related to the environment, but unrelated to industrial policy or carbon emissions, such as wetland protection.[13] A second hypothesis relates to the votes that are particularly close to passage. As opposed to votes on issues with more clear bipartisan support or resistance, party leadership may "coordinate" caucus voting behavior on issues that are very close to passage or defeat. Thus, we would expect that Congressional members may have increased latitude when voting on bills or motions that are expected to handily pass or fail. Although no clear guidelines exist for what constitutes a "close" vote, we define votes that passed or failed by less than five percent of the vote to be "close." Figure 5 plots the histogram of pro-environment vote share for all 207 of the issues tracked by the LCV between 2004 and 2011. Graphically, the votes falling between the dotted lines represent the issues close to passage. Using this criterion, 73 of the 207 the votes are classified as close votes. Votes that are close are roughly equally distributed across all three categories of environmental votes. Table 7 presents the results allowing for the effects of anomalous weather to vary based on vote characteristics. As before, the three columns correspond to specifications without

[13] A list of all the votes and classifications are available from the authors by request.

Figure 5: Environmental vote share for LCV-tracked votes



fixed effects, with year fixed effects, and with month-year fixed effects. Focusing on our preferred specification in column (3), we find that anomalous weather is uncorrelated with voting for the least-relevant group of environmental issues. In contrast, we find a significant, positive correlation between anomalous weather and voting on bills and motions that are more closely related to carbon emissions or industrial pollution. We estimate that a one standard deviation increase in the search intensity is correlated with a 8.4 percentage point increase in the likelihood of a representative taking a pro-environment stance on a vote related to industrial pollution and an 11 percentage point increase in the likelihood related to carbon emissions policy. Although we cannot distinguish whether anomalous weather affects voting through constituent preferences or a representative's own beliefs, we find the strongest correlation between voting and extreme weather exactly where political economy would suggest. In addition, we find suggestive evidence of diminished influence of unusual weather on bills and motions very close to passage.

It is important to qualify the results above in two respects. First, the correlation between voting and search intensity reflects the voting of individual members, conditional on the actual legislation brought to a vote. While we find that members of Congress (and in particular, Democrats) are more likely to vote in favor of environmental regulation when home-state relative search intensity for global warming or climate change tends to be high, we cannot assess whether this implies discrete changes in the passage of legislation or the changes in the content of legislation brought to a vote. Most of the votes tracked by the LCV were passed or defeated with substantial support; in these cases, the vote of a single member is unlikely to be marginal ex-ante and members of Congress may have more latitude to take a position contrary to the position of their party. Only 15 percent of the votes tracked by the LCV were passed (or defeated) by less than a five percentage point margin. Members (and caucuses) may behave differently for votes close to passage or defeat. We nonetheless feel that the observed relationship to marginal voting behavior is meaningful. The relationship illustrates that abnormal weather or high search intensity is related to important, observable behavior on environmental issues. Although the political economy of the legislative process makes it unlikely that the marginal effect of an individual Congressional member would translate into discrete changes in policy, our results suggest that search activity may be a useful proxy for constituent concern and the salience of particular policy issues.

Second, while we identify an effect of abnormal weather on pro-environment voting, it is beyond the reach of our existing data to map a clear causal chain from weather to legislative action. As we note above, we are not arguing that search activity itself is solely responsible for the changes in voting behavior we identify, but rather that search activity (once instrumented) represents a possible proxy for the abnormality of weather. As the previous literature [11, 14, 13] notes, many factors drive the voting of legislators, from ideological preferences and interactions with concerned constituents to longer-run concerns about re-election and the ability to generate campaign contributions. Whether the link to voting behavior arises because constituents express greater concern for the environment or legislators themselves change their personal views is a topic for future research. That said, the short run nature of our identifying variation does suggest that the effect is not entirely driven by a long-run shift in ideological preferences or a desire to demonstrate a *consistent* pro-environment stance to voters.

5. Conclusion

Anthropogenic climate change remains a societal threat and major policy challenge. Public opinion on the existence and severity of climate change has fluctuated considerably over recent decades. Forming accurate beliefs about a long-term one-time event such as climate change places an enormous informational burden on the actor. Unusual weather is an observable, short-term analog that could be used to update one's opinion regarding climate change.

This paper tests the extent to which the salience of climate change is affected by such short-run weather deviations. We use Google Insights search data to proxy for salience, which allows us to perform our analysis at the state-week level. We find that search intensity does indeed respond to weather deviations. Further, the high temporal resolution of our data allows us to provide a number of novel insights. The effect of weather on search intensity varies substantially across the seasons. Unusually cold temperatures have a large effect only in the fall and winter; unusually warm weeks are associated with increased search only in the winter and summer. There does not appear to be much of a relationship between spring weather and search.

We demonstrate that similar patterns exist in the environmental voting record of members of the U.S. Congress. We find that members, and in particular Democrats, are more likely to vote in favor of environmental legislation when their home state experiences anomalous weather or high search activity related to global warming and climate change. The effect of unusual weather is stronger for environmental regulation closely related to climate change or industrial emissions than environmental regulation unrelated to industrial or carbon policy and absent for votes unrelated to environmental policy. In addition, the effects are less strong for "close" votes for which political concerns and vote coordination by party leadership seem to outweigh the effects of unusual weather. While modest in size, the results provide an important, policy-relevant link between anomalous weather and observable action on environmental issues. In addition, the results suggest that search activity may be a useful proxy for the salience of particular policy issues, an important political consideration that is typically difficult to assess.

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Table 1: Descriptive Statistics, Full Sample

		Max. Temp. (°C)	Precip. (mm)	Snowfall (mm)	Snow Depth (mm)	Google Search Index
Full sample:	Mean	-0.0331	0.1044	0.4892	4.3219	39.651
(N = 16546)	SD	3.2633	2.7115	6.0449	42.619	28.284
Winter:	Mean	-0.7083	-0.0260	1.7908	14.411	43.021
(N = 4269)	SD	4.0552	2.4107	10.141	73.259	29.640
Spring:	Mean	0.2705	0.1031	0.0685	2.8974	47.101
(N = 4320)	SD	3.2284	2.7223	4.8793	37.368	30.495
Summer:	Mean	0.1994	0.1362	0.0006	0.2317	23.318
(N = 3485)	SD	2.1956	2.6152	0.0525	3.7803	16.440
Fall:	Mean	0.1371	0.2055	0.0337	-0.7467	41.964
(N = 4472)	SD	3.0479	3.0242	3.4447	10.026	27.114

Notes: All weather variables are deviations from the 10-year baseline covering 1994-2003. Sample period is from 2004-2011.

Table 2: Weather correlations

	Max temp	Precip	Snowfall
Max temp	·	·	·
Precip	-0.1077	·	·
Snowfall	-0.3204	0.1248	·
Snow depth	-0.2704	0.0312	0.4760

Notes: All weather variables are deviations from the 10-year baseline covering 1994-2003. Sample period is from 2004-2011.

Table 3: Effect of weather deviations on search intensity

Panel A: Linear Specification

	(1) All Seasons	(2) Winter	(3) Spring	(4) Summer	(5) Fall
Max Temp, deg. C	-0.240***	-0.654***	-0.074	0.232*	-0.046
	(0.064)	(0.112)	(0.089)	(0.120)	(0.088)
Precip., mm	-0.007	0.177*	0.020	0.106*	-0.026
	(0.047)	(0.097)	(0.086)	(0.058)	(0.091)
Snowfall, mm	-0.042*	-0.094***	0.025	5.690*	0.065
	(0.021)	(0.023)	(0.052)	(3.384)	(0.090)
Snow Depth, mm	-0.018*	-0.024**	-0.001	-0.009	-0.118***
	(0.009)	(0.009)	(0.022)	(0.020)	(0.040)
Constant	23.781***	22.758***	62.722***	93.443***	58.605***
	(1.541)	(1.572)	(1.256)	(1.974)	(1.607)
Observations	16,546	4,269	4,320	3,485	4,472
R-squared	0.761	0.684	0.780	0.781	0.737

Panel B: Asymmetric Specification

	(1) All Seasons	(2) Winter	(3) Spring	(4) Summer	(5) Fall
Pos dev, Max Temp, deg. C	0.292***	0.547***	-0.110	0.707***	0.082
	(0.078)	(0.155)	(0.142)	(0.163)	(0.178)
Neg dev, Max Temp, deg. C	0.806***	1.634***	-0.026	0.322*	0.246*
	(0.101)	(0.172)	(0.139)	(0.192)	(0.133)
Pos dev, Precip., mm	0.057	0.844***	-0.096	0.018	-0.080
	(0.073)	(0.160)	(0.133)	(0.074)	(0.110)
Neg dev, Precip., mm	0.122	1.048***	-0.311	-0.285**	-0.159
	(0.124)	(0.244)	(0.203)	(0.139)	(0.161)
Pos dev, Snowfall, mm	0.003	-0.047	0.024	7.961*	0.132*
	(0.029)	(0.029)	(0.066)	(4.055)	(0.070)
Neg dev, Snowfall, mm	0.285***	0.256**	-0.039	11.321	0.774**
	(0.088)	(0.101)	(0.117)	(29.207)	(0.317)
Pos dev, Snow Depth, mm	-0.007	-0.003	-0.032*	0.027	0.019
	(0.009)	(0.009)	(0.019)	(0.037)	(0.055)
Neg dev, Snow Depth, mm	0.045**	0.076***	-0.067	0.540	0.300**
	(0.020)	(0.023)	(0.060)	(0.527)	(0.122)
Constant	21.408***	16.192***	27.028***	90.708***	60.040***
	(1.662)	(1.874)	(1.218)	(2.086)	(1.416)
Observations	16,546	4,269	4,320	3,485	4,472
R-squared	0.763	0.696	0.781	0.783	0.741

Notes: *** p<0.01, ** p<0.05, * p<0.1. Dependent variable is the Google search index. All regressions also include year * month FE and state * month of year FE. Standard errors are clustered at the state level.

Table 4: Environmental Votes, Local Weather and Search Intensity

	(1)	(2)	(3)
Panel A: Weather variables			
Pos Dev, Max Temp	0.00004	0.00032	-0.00092
	(0.00208)	(0.00195)	(0.00166)
Neg Dev, Max Temp	-0.00467***	-0.00588***	-0.00257
	(0.00148)	(0.00150)	(0.00159)
Pos Dev, Snowfall	-0.00048	-0.00024	-0.00040
	(0.00038)	(0.00036)	(0.00032)
Neg Dev, Snowfall	0.00385**	0.00265	0.00190
	(0.00189)	(0.00181)	(0.00186)
Pos Dev, Precipitation	0.00194	0.00075	0.00053
	(0.00139)	(0.00128)	(0.00124)
Neg Dev, Precipitation	-0.00116	0.00024	-0.00113
	(0.00234)	(0.00219)	(0.00260)
Pos Dev, Snow Depth	0.00002	0.00003	0.00004
	(0.00006)	(0.00007)	(0.00005)
Neg Dev, Snow Depth	0.00012	0.00013	-0.00001
	(0.00021)	(0.00020)	(0.00021)
F-test p-value	<0.001	<0.001	0.147
Observations	61173	61173	61173
R-Squared	0.654	0.657	0.672
Panel B: Weather-correlated with Search Intensity			
Climate Change Search Intensity/100	0.313***	0.254***	0.111**
	(0.0601)	(0.0557)	(0.0475)
Observations	61148	61148	61148
R-Squared	0.655	0.657	0.672

Notes: *** p<0.01, ** p<0.05, * p<0.1. Dependent variable is a binary variable indicating whether a representative voted for the LCV-endorsed position. All specifications include representative fixed effects. In addition, column (2) includes year * month fixed effects and column (3) includes year * week fixed effects. Standard errors are clustered at the state level.

Table 5: ACU Votes, Local Weather and Search Intensity

	All ACU-tracked votes			Same-week ACU-tracked votes		
	(1)	(2)	(3)	(4)	(5)	(6)
Climate Change Search Intensity/100	-0.0253	-0.00977	0.0500*	0.0249	-0.0165	-0.00344
	(0.0258)	(0.0265)	(0.0280)	(0.0349)	(0.0375)	(0.0494)
Observations	90143	90143	90143	41509	41509	41509
R-Squared	0.551	0.554	0.569	0.542	0.549	0.573

Notes: *** p<0.01, ** p<0.05, * p<0.1. Dependent variable is a binary variable indicating whether a representative voted for the ACU-endorsed position. All specifications include representative fixed effects. In addition, columns (2) and (5) include year * month fixed effects and columns (3) and (6) include year * week fixed effects. Standard errors are clustered at the state level.

Table 6: Environmental Votes and Search Intensity, by Representative Characteristics

	(1)	(2)	(3)
Climate Change Search Intensity/100	0.167**	0.104	-0.0584
	(0.0770)	(0.0742)	(0.0684)
Senate * Search Intensity/100	-0.111	-0.131*	-0.0461
	(0.0709)	(0.0712)	(0.0687)
Democrat * Search Intensity/100	0.276***	0.289***	0.298***
	(0.0959)	(0.0950)	(0.0888)
Observations	61148	61148	61148
R-Squared	0.655	0.658	0.672

Notes: *** p<0.01, ** p<0.05, * p<0.1. Dependent variable is a binary variable indicating whether a representative voted for the LCV-endorsed position. All specifications include representative fixed effects. In addition, column (2) includes year * month fixed effects and column (3) includes year * week fixed effects. Standard errors are clustered at the state level.

Table 7: Environmental Votes and Search Intensity, by Vote Characteristics

	(1)	(2)	(3)
Other Vote * Search Intensity/100	0.295***	0.213***	-0.0191
	(0.0710)	(0.0660)	(0.0667)
Industrial Regulation * Search Intensity/100	0.370***	0.316***	0.310***
	(0.0783)	(0.0779)	(0.0853)
Climate Change * Search Intensity/100	0.290***	0.283**	0.395**
	(0.102)	(0.112)	(0.172)
Close vote * Search Intensity/100	-0.0969***	-0.0654***	-0.101***
	(0.0172)	(0.0159)	(0.0211)
Observations	61148	61148	61148
R-Squared	0.655	0.658	0.672

Notes: *** p<0.01, ** p<0.05, * p<0.1. Dependent variable is a binary variable indicating whether a representative voted for the LCV-endorsed position. All specifications include representative fixed effects. In addition, column (2) includes year * month fixed effects and column (3) includes year * week fixed effects. Standard errors are clustered at the state level.