RESOURCES
for the FUTURE

Climate Change Salience and Electricity Consumption: Evidence from Twitter Activity

Jacopo Bonan, Daniele Curzi, Giovanna d'Adda, and Simone Ferro

Working Paper 23-34
August 2023

About the Authors

Jacopo Bonan is an affiliated scientist with the European Institute on Economics and the Environment (EIEE). He is an assistant professor at the School of Management of Politecnico di Milano. He obtained the MSc in economics at the University of Edinburgh and the PhD in economics at the University of Milan-Bicocca. He has been a research fellow at the Catholic University of Milan and junior researcher at Fondazione Eni Enrico Mattei (FEEM). His research focuses on development economics with an emphasis on energy access and efficiency, health, agriculture, formal and informal financial institutions. He is specialized in the design of impact evaluations and coordinated several randomized controlled trials in Sub-Saharan Africa and South Asia.

Daniele Curzi is a postdoctoral researcher at the University of Milan.

Giovanna d'Adda is an assistant professor at the University of Milan and scientist at EIEE, where she is head of the research area on behavioral science. Previously, she worked at Milan Polytechnic and the University of Birmingham and was a visiting researcher at FEEM. She holds a PhD in economics from Bocconi University, with a thesis on natural resource conservation in developing countries, and an MSc in Development Management from LSE. During her PhD, Giovanna was a research fellow at Harvard Kennedy School, Paris School of Economics and University of Zurich. Giovanna's research uses laboratory and field experiments to investigate key drivers of pro-social behavior, such as institutions, norms, and leadership structures. Her recent work has focused on the analysis of the impact of behavioral energy efficiency programs.

Simone Ferro is a postdoctoral researcher at the University of Milan and affiliated scientist at EIEE. He holds a PhD in economics from the Queen Mary University of London and an MSc in economics from Bocconi University. Before his PhD, Simone served as full-time research assistant at Fondazione Rodolfo de Benedetti. Simone's work focuses on labor and health economics. His current research agenda includes studies on the long-term health consequences of prenatal exposure to air pollution, on the effect of weather conditions on the spread of viral diseases, and on the effect of weather anomalies on consumers' behavior.

Acknowledgments

We acknowledge financial support from the University of Milan (SEED grant, project Warming). We thank Silvia Pianta and Matt Sisco for kindly sharing their data on climate change news and for useful feedback on the paper. We thank Maurizio Maugeri for supplying the temperature data. We thank Stefania Renna for her excellent research assistance.

About RFF

Resources for the Future (RFF) is an independent, nonprofit research institution in Washington, DC. Its mission is to improve environmental, energy, and natural resource decisions through impartial economic research and policy engagement. RFF is committed to being the most widely trusted source of research insights and policy solutions leading to a healthy environment and a thriving economy.

Sharing Our Work

Climate change salience and electricity consumption: Evidence from Twitter activity

[1], Jacopo Bonan[1,3], Daniele Curzi[2], Giovanna d'Adda[2,3], and Simone Ferro[2,3]

[1]Politecnico di Milano, Italy
[2]University of Milan, Italy
[3]RFF-CMCC European Institute on Economics and the Environment (EIEE), Centro Euro-Mediterraneo sui Cambiamenti Climatici, Italy

Abstract

We employ electricity-use data covering 1,500,000 Italian households for 2015–2019 and a granular measure of social media attention to climate change derived from universal-coverage Twitter data to show that increases in climate change salience induced by exogenous sociopolitical and climatic events cause a significant reduction in energy consumption. Sentiment analysis suggests that natural disasters and climate strikes are associated with emotions that are strong motivators for action. These results imply that episodes that draw attention to climate change may lead to actual behavioral change, but their effect is short lived.

Keywords: Climate change salience, social media, energy consumption

JEL codes: D12, D91, Q41

1 Introduction

The prominence of climate change in citizens' life has been rising steadily in recent decades. In the private sphere, consumers pay increasing attention to the environmental impacts of their choices (Steg and Vlek, 2009; Saari et al., 2021), and representative surveys indicate rising levels of individual awareness of climate change (Capstick et al., 2015b; Duijndam and van Beukering, 2021; Stoddard et al., 2021). Although climate change salience in everyday life is a multifaceted and hard-to-measure construct, it is correlated with the attention given to global warming and environmental issues in the media and on social media. The growth in media attention to climate change mirrors that in awareness of it (Brechin and Bhandari, 2011; Capstick et al., 2015a). Over the past decades, spikes in media attention have accompanied extreme weather events (Sisco et al., 2017; Pianta and Sisco, 2020); episodes of climate activism and protests for climate justice (Sisco et al., 2021); and international climate conferences, such as Conferences of the Parties (CoPs) (Ahchong and Dodds, 2012; Schmidt et al., 2013). The literature demonstrates the influence of media and social media on behavior in a wide range of settings, such as collective action events, violence, polarization, and political outcomes (Zhuravskaya et al., 2020; Campante et al., 2022). In the environmental domain, the literature predominantly explores the influence of media and social media content on self-reported opinions and beliefs on climate change and intentions to act proenvironmentally rather than on real-world proenvironmental behaviors.

We address how climate change salience influences environmental conservation by focusing on a policy-relevant and understudied behavioral outcome, electricity consumption. Energy consumption in buildings is a key contributor to global warming, and reducing residential energy usage is crucial in the fight against climate change (IEA, 2019). We proxy climate change salience with social media attention. We test the impact of attention to climate change on electricity consumption in Italy by exploiting variations in climate-related Twitter content due to plausibly exogenous shocks, such as natural disasters, climate strikes, and international climate conferences. Using these shocks as instrumental variables, we isolate exogenous increases in climate change salience and investigate to what extent they translate into more sustainable electricity consumption. We document how different types of events, from sociopolitical to natural, affect media attention to climate change and its associated emotions.

Our analysis identifies natural disasters abroad and climate strikes as key drivers of climate change salience. A one standard deviation increase in the volume of climate-related tweets in a month induced by these events causes a mild but statistically significant 4 percent of a standard deviation decrease in energy consumption in the same month, corresponding to a 1 percent reduction on average. The effect disappears in subsequent months; this is consistent with existing evidence on the short-lived effects of external events on beliefs in climate change (Zaval et al., 2014) and the mechanisms behind salience-induced behavioral change (Bordalo et al., 2022). It also suggests that consumers do not respond to increased salience by investing in efficient energy-using durables. Although we cannot test the causal relationship between tweets' emotional content and energy conservation behavior, sentiment analysis reveals that most climate-related tweets embody negative emotions, primarily anger, which is a strong motivator for action (Stanley et al., 2021; Ojala et al., 2021). Our results are, therefore, consistent with the evidence on the relationship between emotions and proenvironmental behavioral intentions.

The evidence on how climate change salience affects environmental conservation typically demonstrates how exposure to climate-related media and social media content increases self-reported environmental beliefs, awareness, concerns and behavioral intentions (Brulle et al., 2012; Carvalho, 2010; Moser, 2010; Williams et al., 2015; Sampei and Aoyagi-Usui, 2009). The few works focusing on real-world behaviors examine the impact of media coverage on visible, one-off behaviors, such as purchasing an electric vehicle or solar panel, and attribute part of its effect to the social norms conveyed by the media (Chen et al., 2019; Bollinger and Gillingham, 2012). By focusing on energy efficiency, our study broadens the scope of this literature on two fronts. First, energy efficiency is a less visible proenvironmental behavior than electric vehicle or solar panel purchases and potentially less responsive to social image concerns. Second, while investment in energy efficiency is a one-off choice with long-term repercussions, reductions in energy usage result partly from sustained effort over time; our analysis can therefore shed light on the dynamic effects of changes in climate change salience.

A related literature examines how exposure to extreme weather events affects self-reported beliefs in climate change and support for environmental policies, showing mixed results (Bergquist et al., 2019; Borick and Rabe, 2017; Egan and Mullin, 2014; Howe et al., 2019; Howe, 2021; Hughes et al., 2020; Ogunbode et al., 2019; Zaval et al., 2014). Fewer studies look at the impact of weather anomalies on actual behavior, focusing mainly on voting (Baccini and Leemann, 2021; Hazlett and Mildenberger, 2020; Hoffmann et al., 2022). Our analysis identifies extreme weather events as a significant source of variation in climate change salience and, through it, in energy consumption.

Our study also presents evidence on how different climatic and sociopolitical events correlate with the emotional content of climate-related tweets. Emotions may mediate the influence of exposure to climate change news on behaviors and attitudes. Studies of how emotions influence proenvironmental attitudes find that positive emotions, such as solution-oriented hope and solidarity, and negative emotions, such as anger, are both strongly related to pro-environmental intentions (Harth et al., 2013; Xie et al., 2019; Schneider et al., 2021; Brosch, 2021) but have short-lived effects (Schwartz and Loewenstein, 2017). Evidence is lacking on their impact on real-world behaviors (Bergquist et al., 2020).

Our analysis has limitations. First, our empirical strategy relies on time-varying shocks to climate-related Twitter activity, raising the concern that changes in such tweets may capture other time-varying sources of variation in electricity consumption. Our results are robust to a series of tests aimed at mitigating this concern, such as adding increasingly demanding controls to our regression models and exploring different combinations of instrumental variables. Second, climate-related tweets are an imperfect proxy of climate change salience at the social level. To address this concern, we show that our indicator meaningfully correlates with the presence of climate change–related news in traditional media, so it relates to such salience in the media more broadly. Social media attention is also correlated with available survey measures of concern for climate change, suggesting that it captures engagement with environmental issues.

The remainder of the paper presents the data (Section 2), empirical strategy and results (Section 3), and conclusion (Section 4).

2 Data and Descriptive Statistics

2.1 Data

Our analysis combines data on social media attention to climate change derived from Twitter with household-level electricity usage data from a large Italian utility. To exploit exogenous sources of variation in social media attention, we collect information on natural disasters elsewhere in the world, CoPs, and climate strikes in Italy and abroad. Our analysis covers January 2015 to December 2019.

We identify climate-related tweets as tweets in Italian mentioning "climate change" or "global warming" in Italian or English, both with and without spaces. We replicate this procedure on a neutral keyword to proxy for the general level of Twitter activity.[1] We then identify the user's province of residence by geocoding their self-reported location.[2] We obtain approximately 270,000 climate-related tweets and can geolocate 36 percent of these at the provincial level. We define the index of social media attention to climate change at the province (NUTS-3)-month level as the share of climate-related tweets over the total number of "neutral" tweets written by users in the province during the month.

The index of social media attention to climate change is meaningfully correlated with other indicators of climate change salience within society and socioeconomic characteristics. First, the index mirrors the prevalence of Italian newspaper articles mentioning the keywords “climate change” or “global warming” during the study period (Appendix Figure A.1), taken from Pianta and Sisco (2020).[3] Second, when aggregated at the regional level, the index shows a strong correlation (0.61, $p = 0.002$) with representative data on the share of individuals listing climate change among their major environmental concerns (Figure 1) collected by the national statistical office (Istat). Third, the index correlates meaningfully with province characteristics (Appendix Figure A.2): it is positively correlated with income, the share of high school graduates, indicators of social capital, such as newspaper reading and blood donations, hydrogeologic risk, and the number of climate strikes. This suggests that the level of climate change attention on Twitter is a good indicator of the general level of awareness and corroborates our use of this measure as a proxy of climate change salience. Our index has two key advantages over alternative measures of presence on the news or environmental concern. First, it provides a proxy of climate change concerns at a higher level of spatial granularity. Second, it varies over the entire study period at the monthly level.

We perform sentiment analysis to distinguish whether climate-related tweets convey negative or positive emotions. We further decompose negative emotions between sadness, fear, and anger. Positive emotions encompass joy, solidarity and hope. We classify each tweet's sentiment and emotional content with a model trained and validated on a corpus of Italian Twitter posts (Bianchi et al., 2021). Appendix Table A.1 reports examples of tweets in the four categories. We examine the composition and evolution of tweets' emotional content and test how representative the subset of geolocated tweets are of the whole sample of tweets by plotting the distribution of sentiment and emotions and evolution of the number of tweets over time for the two groups (Appendix Figures A.3 and A.4). Anger is the prevailing emotion, although its share decreases over time, with a corresponding increase in the shares of other emotions. These patterns are virtually identical between the geolocated and total tweets. This suggests that the geolocated tweets are representative of the universe of climate-related tweets in Italy.

Electricity consumption data are provided by a multiutility present on the entire Italian territory that had about 1,500,000 residential electricity customers distributed in all 107 provinces (Appendix Figure A.5, top panel). For all customers, we have access to historical electricity consumption data from January 2015 to December 2019. We compute the monthly average daily usage from the total monthly consumption billed to customers. We exclude households with 0 consumption in some months (9 percent of the sample) and users whose minimum, maximum, or minimum-to-maximum consumption is higher than 1.5 interquartile ranges above the third quartile of the corresponding distributions (14 percent of the sample). We obtain a final sample of 62,000,000 observations from 1,476,438 unique households. Our sample's average daily usage is 6.1 KWh (the monthly standard deviation is 16.9 KWh) and varies significantly across municipalities (Appendix Figure A.5, bottom panel). Usage appears relatively stable over the study period and displays the typical seasonal pattern, with peaks in winter and summer (Appendix Figure A.6).[4]

Natural disasters abroad, CoPs, and climate strikes are the potential sources of variation in climate-related tweets that we consider in the analysis. We employ EM-DAT (http://www.emdat.be/database), an emergency events database collected by the Centre for Research on the Epidemiology of Disasters, to compute the monthly number of natural disasters (e.g., droughts, floods, wildfires, and extreme temperature episodes) worldwide, excluding Italy; the average is 28, with a standard deviation of 9.2. We focus on CoPs, as they are the most important recurring political events addressing climate change. CoPs represent the decision making body of the United Nations Framework Convention on Climate Change. They involve representatives of 198 states, and their primary objective is to assess progress in dealing with climate change and establish legal obligations to reduce countries' greenhouse gas emissions. The meetings are organized annually (between November and December in the sample period) and generally last between 11 days and 2 weeks. Based on the starting and ending dates of each conference, we built an indicator variable for months when a CoP was taking place. When a conference spans two months, we only consider the most represented one. Finally, we employ the events archive of the Fridays for Future movement to measure the number of climate strikes and demonstrations in Italy and abroad.[5]

We also control for temperature. Data on the surface temperature are taken from the ERA5-Land database (Muñoz Sabater, 2019). We collect hourly gridded data at 0.1° x 0.1° resolution, which we then aggregate daily and match with the considered Italian provinces using their centroids.

2.2 Descriptive analysis

The top panel of Figure 2 displays the change in social media attention to climate change over time, segmented by sentiment, alongside the general level of Twitter activity. In Italy, Twitter activity increased sharply since 2010, peaked in 2013, and then remained roughly stable in the following years. Between 2010 and 2018, the number of climate change tweets has risen gradually but consistently. The top panel of Figure 2 also shows that negative emotions, such as fear and anger, are prevalent in climate-related tweets. In the bottom panel of Figure 2, we restrict to the study period and show the index of social media attention to climate change (the ratio between the number of climate change tweets and the level of Twitter activity). The panel also shows the monthly number of climate strikes organized in Italy. Spikes in attention are noticeable toward the end of 2015, when the Paris Agreement was signed, and from November 2018 onward, in correspondence with the first climate strikes. Climate change attention on Twitter reached its maximum at the time of the global Fridays for Future climate strikes in March, May, September, and November 2019. The upward trend in media attention to climate change persisted until the beginning of 2020, when the first COVID-19 outbreak occurred in Italy. These trends point to a major influence of sociopolitical events on social media's attention to climate change.

3 Empirical Strategy and Results

Average electricity consumption negatively correlates with social media attention to climate change (Appendix Figure A.7). However, such a correlation and a simple regression of our index on electricity consumption would not produce an estimate of the causal effect of climate change salience on consumption. First, as observed, climate change attention is higher in provinces with higher education, income, and social capital. These and other unobserved characteristics may independently influence both consumption and salience (Jones et al., 2015). Second, several other factors, including local policies to reduce emissions, may contribute to simultaneously determining the local level of climate change salience and electricity consumption. Third, peaks in electricity consumption occur at high temperatures, such as abnormal heat waves, which independently increase the salience of global warming. More generally, local weather is a key determinant of electricity consumption and attention to climate change (Zaval et al., 2014; Alberini et al., 2019). The simultaneous effect of local weather conditions on salience and consumption may be too complex to control in a parametric regression. Fourth, we observe an imperfect proxy of salience within society. This may lead to attenuation bias from measurement error, which could distort estimates toward 0.

All of these sources of potential bias can lead an ordinary least squares regression to be an inconsistent estimator. We overcome these identification challenges using an instrumental variables approach. In our empirical strategy, we exploit sources of variation in climate change salience, proxied by social media attention, that are exogenous to electricity consumption. Specifically, we first examine how climate strikes, natural disasters abroad, and CoPs affect attention to climate change on Twitter. We then take the strongest predictors as instrumental variables for salience. Our empirical strategy controls for various determinants of households' energy consumption through fixed effects. In particular, our models absorb province characteristics, seasonality, and local weather through province fixed effects, provincial-level quadratic time trends, month fixed effects, and flexible controls for temperature.

3.1 The determinants of climate change salience

The first step of our empirical analysis investigates the impact of sociopolitical and climatic events on climate change salience. We employ a multiple regression model saturated with province fixed effects, provincial-level quadratic trends and seasonality, and flexible controls for temperature. The control variables are added progressively to reach the richest, preferred specification. The residual variation in the explanatory variables we employ for identification stems from nonseasonal deviations from the provincial trends.

More formally, we estimate the following regression model:

$$CCS_{pt} = \beta SPC_t + \delta_{pm} + \gamma_p t + \theta_p t^2 + f(Temp) + \mu_{pt}, \tag{1}$$

where CCS_{pt} is the measure of climate change salience (proxied by social media attention to climate change on Twitter) in province p at time t (month), δ_{pm} absorbs provincial fixed effects and local seasonalities, $\gamma_p t$, $\theta_p t^2$ captures differential provincial quadratic trends, and $f(Temp)$ is a flexible function of temperature. Finally, SPC_{pt} is a vector of sociopolitical and climatic events, which includes an indicator for a CoP taking place in t, the aggregate count of natural disasters happening outside Italy in t, and the number of climate strikes organized in Italy in t. Standard errors are clustered both at the provincial level, to allow for temporal correlation of the error term, and at the monthly level, the highest level at which explanatory variables vary. Observations in the regressions are weighted by their corresponding level of the Twitter activity index (the denominator of the dependent variable).

Table 1 reports results from Equation 1. It shows how climate strikes, natural disasters outside of Italy, and CoPs affect social media attention to climate change. The dependent and explanatory variables are measured in standard deviations for better interpretability and comparability of the coefficients. Results from our preferred specification indicate that a one standard deviation increase in the number of climate strikes and natural disasters abroad is significantly associated with a 29 and 10 percent of a standard deviation increase in climate change attention on Twitter, respectively (Column 4). Estimated coefficients are stable across specifications as controls are progressively added (Columns 1–3). Such stability supports our ability to interpret these estimates causally. The effect of CoPs on salience becomes insignificant once we control for seasonality (Column 2, $p = 0.12$); this may be because CoPs always occurred in November and December during our study period, and thus their effect is absorbed by the month of the year fixed effects. Altogether, our estimates point to substantial increases in climate change salience in correspondence with global sociopolitical or climatic events and a major role of climate strikes in social media attention to the topic.

To investigate how different shocks affect the emotional content of climate change tweets, we replicate our preferred specification but disaggregate the index by emotion: anger, fear, sadness, and joy (the latter captures feelings of solidarity and hope). The results are summarized by the coefficients plot in Figure 3. Natural disasters and CoPs are associated with similar impacts on different emotions. Climate strikes have stronger effects on angry and joyful tweets. These results suggest that climate strikes, besides having the strongest effect on climate change salience overall, are also associated with emotional responses that are most conducive to action (Stanley et al., 2021; Brosch, 2021).

3.2 The effect of climate change salience on electricity consumption

To investigate the effect of exogenous changes in climate change salience on electricity consumption, we employ a 2SLS approach. We use the utility's entire customer base i.e., about 1,500,000 customers, and run regressions at the individual-month level.

In the first stage, we instrument our proxy of climate change salience (CCS_{pt}) with its strongest exogenous predictors. Specifically, we focus on the two most relevant determinants of media attention to climate change from the previous analysis (natural disasters outside of Italy and national climate strikes). We estimate the first stage:

$$CCS_{pt} = \beta_1 CS_t + \beta_2 ND_t + \delta_{pm} + \gamma_i t + \theta_p t^2 + f(Temp) + \mu_{ipt}, \tag{2}$$

where CS_t and ND_t are the number of climate strikes in Italy and major climatic disasters abroad, respectively, in month t, γ_i absorbs individual fixed effects, and all other variables can be interpreted as in Equation 1.

In the second stage, we employ the fitted value of Equation 2 ($\widehat{CCS_{pt}}$) to investigate how exogenous changes in climate change salience stemming from sociopolitical and climatic events affect electricity consumption.

$$C_{ipt} = \beta_2 \widehat{CCS_{pt}} + \delta_{pm} + \gamma_i t + \theta_p t^2 + f(Temp) + \mu_{ipt}, \tag{3}$$

where C_{ipt} is the (standardized) consumption of customer i, in province p, in month t. The identifying assumption is that sociopolitical and climatic events abroad influence electricity consumption only through climate change salience, which we proxy with media and social media attention to climate change.

Necessary conditions for the appropriateness of the 2SLS model are tested through the F-statistics of the first stage regression and the Sargan–Hansen overidentification test. The first one tests the null hypothesis of weak instruments.[6] The second one tests for the validity of the instruments. We report statistics for both tests alongside the regression results.

Table 2 displays regressions results, with the dependent variable, monthly average electricity consumption in a day, expressed in standard deviations in Panel A and in natural logarithm in Panel B. The results from our preferred 2SLS specification suggest that a one standard deviation increase in climate change salience is associated with a 4 percent of a standard deviation decrease in electricity consumption, corresponding to a 0.8 percent decrease in consumption on average (Column 3). The estimated coefficients are stable and robust to the addition of controls (Columns 1–3). When estimating dynamic effects, by including leads (as placebo) and lags of our proxy for climate change salience, we find that electricity consumption is significantly affected by salience only in the same month, but leads and lags are never significant (Column 4). On top of strengthening the causal interpretation of our estimates, these results suggest that the effect of temporary changes in salience on sustainable consumption may be quite ephemeral. This is consistent with its short-lived effect found in the literature (McCoy and Walsh, 2018). Furthermore, the drop in consumption is temporary, suggesting that savings from increased salience primarily stem from reversible behavioral changes rather than investment in more efficient technologies.

The F-statistics of the first stage regression(s) above the rule-of-thumb value of 10 mitigate concerns of weak-instrument bias (Panel C of Table 2). The *p*-values from Sargan–Hansen overidentification tests never reject the null hypothesis that the overidentifying restrictions are valid (Panel C of Table 2).

In Appendix Table A.3, we replicate our preferred specification with different combinations of instruments. The robustness of our estimates across the different specifications, including those where we employ climate strikes organized abroad, mitigates concerns about instrument endogeneity.

To explore the heterogeneous effects of climate change salience by household, municipal, and provincial characteristics, we repeat this analysis on different subsamples. We split the sample between high and low consumers (household electricity usage above and below the sample median over the study period); by gender and age of the contract holder (above and below 60); municipalities with social capital above and below the median; between municipalities with income above and below the median; and between provinces where the index for climate change salience is above and below the median. We find suggestive evidence that effects are stronger for users located in municipalities with lower levels of social capital and income, although effects are not significantly different across subsamples (Appendix Table A.4).

4 Discussion

Recent years have seen a worsening of the impacts of climate change, in part due to extreme weather events, and increasing awareness of among younger generations. Our evidence shows that natural disasters and climate strikes are associated with higher climate change salience, proxied by social media attention. The content of tweets induced by these events suggests that they spur anger and solidarity, which are strong emotional drivers of action. Exploiting exogenous variation in climate change salience due to these natural and social events, our analysis shows that higher salience leads to reductions in electricity consumption among a sample of almost 1,500,000 households in Italy.

The effects we uncover are novel, as no previous study has documented the impact of climate change salience on energy conservation behavior on a large scale. The magnitude of these effects is also meaningful. A one standard deviation increase in climate change salience saves 52 Gwh/month, or 1 percent of monthly Italian households' electricity consumption. This effect is similar to the estimated decrease in consumption in response to a 3 percent increase in price (Csereklyei, 2020).

In terms of environmental impacts, this effect translates to savings of 15,000 tons of per month or 0.06 percent of total Italian emissions. Converting these figures to social benefits (Greenstone et al., 2013), we estimate that a one standard deviation increase in climate change salience generates $3,800,000 per year in social benefits. More concretely, our estimates suggest that each climate strike, of the 638 we observe in our data, saves 862 thousand Kwh and 255 tons of , which can be quantified as $5,300 of social benefits. Overall, these figures highlight how increased salience of climate change issues can spur concrete proenvironmental actions, although of small magnitude and short-lived duration.

One limitation of our analysis is that the identification of the effects of interest in our preferred specification stems only from common time-varying shocks. Nevertheless, a series of coherent results corroborate the causal interpretation of our estimates. First, our estimates are extremely robust to different model specifications, including the most saturated versions, which include, together with the individual fixed effects, province-specific quadratic time trends and seasonality. Second, virtually identical results can be obtained by employing different combinations of instrumental variables, including climate strikes measured at the provincial level and events abroad. Finally, and perhaps most importantly, according to our estimates, electricity consumption only responds to contemporaneous (instrumented) changes in climate change salience and is not significantly associated with changes in the previous or following months. Together with the lack of any clear reason to hypothesize spurious correlations between changes in the number of natural disasters or climate strikes and climate change salience or electricity consumption, these results corroborate the causal interpretation of our estimates.

Our study is also not equipped to identify the mechanisms explaining the stronger conservation effort following peaks in climate change salience. Our results on the emotional content of climate-related tweets are consistent with the literature on the effect of emotions in motivating proenvironmental intentions (Brosch, 2021). Salience may also stimulate and prompt environmental identity, which is a driver of proenvironmental behavior (van der Werff et al., 2013; Bonan et al., 2021),and play a role in shaping and reinforcing the social norm in favor of resource conservation (Yanovitzky and Stryker, 2001). One may question the relevance of these mechanisms, as energy conservation is less subject to social image and peer pressure (Mundaca and Samahita, 2020; Chen et al., 2019; Ariely et al., 2009) than one-off purchases of products that are publicly visible, such as electric vehicles and solar panels. Nevertheless, social information programs leveraging social norms have proven effective in curbing energy consumption (Allcott, 2011; Allcott and Rogers, 2014; Bonan et al., 2020, 2021).

Moreover, our provincial measure of climate change salience does not cleanly capture individual-level exposure to media content by electricity users in our sample. Further research could address this limitation by randomly varying exposure to climate change–related media content among electricity users. Moreover, exogenous changes in the emotional connotation of messages could be exploited to explore the psychological mechanisms behind our results further.

Finally, although our analysis shows that the 2019 wave of Fridays for Future climate strikes drew attention to climate change channeled into proenvironmental behavior, our results cannot be generalized to all forms of climate activism. In the public arena, some express doubts about the ability of more disruptive manifestations of climate activism, which have made the news recently, to influence citizens' behaviors.

References

Ahchong, Katrina and Dodds, Rachel. Anthropogenic climate change coverage in two canadian newspapers, the toronto star and the globe and mail, from 1988 to 2007. *Environmental Science Policy*, 15(1): 48–59, 2012. ISSN 1462-9011. doi: https://doi.org/10.1016/j.envsci.2011.09.008.

Alberini, Anna, Prettico, Giuseppe, Shen, Chang, and Torriti, Jacopo. Hot weather and residential hourly electricity demand in italy. *Energy*, 177:44–56, 2019. ISSN 0360-5442. doi: https://doi.org/10.1016/j.energy.2019.04.051.

Allcott, Hunt. Social norms and energy conservation. *Journal of Public Economics*, 95(9-10):1082–1095, October 2011. ISSN 0047-2727. doi: 10.1016/j.jpubeco.2011.03.003.

Allcott, Hunt and Rogers, Todd. The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation. *American Economic Review*, 104(10):3003–3037, October 2014. ISSN 0002-8282. doi: 10.1257/aer.104.10.3003.

Ariely, Dan, Bracha, Anat, and Meier, Stephan. Doing good or doing well? image motivation and monetary incentives in behaving prosocially. *American Economic Review*, 99(1):544–55, March 2009. doi: 10.1257/aer.99.1.544.

Baccini, Leonardo and Leemann, Lucas. Do natural disasters help the environment? How voters respond and what that means. *Political Science Research and Methods*, 9(3):468–484, July 2021. ISSN 2049-8470, 2049-8489. doi: 10.1017/psrm.2020.25. Publisher: Cambridge University Press.

Bergquist, Magnus, Nilsson, Andreas, and Schultz, P. Wesley. Experiencing a Severe Weather Event Increases Concern About Climate Change. *Frontiers in Psychology*, 10, 2019. ISSN 1664-1078, `https://www.frontiersin.org/articles/10.3389/fpsyg.2019.00220`.

Bergquist, Magnus, Nyström, Lina, and Nilsson, Andreas. Feeling or following? A field-experiment comparing social norms-based and emotions-based motives encouraging pro-environmental donations.

Journal of Consumer Behaviour, 19(4):351–358, 2020. ISSN 1479-1838. doi: 10.1002/cb.1813. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/cb.1813.

Bianchi, Federico, Nozza, Debora, and Hovy, Dirk. FEEL-IT: Emotion and sentiment classification for the Italian language. In *Proceedings of the Eleventh Workshop on Computational Approaches to Subjectivity, Sentiment and Social Media Analysis*, pages 76–83, Online, April 2021. Association for Computational Linguistics, `https://aclanthology.org/2021.wassa-1.8`.

Bollinger, Bryan and Gillingham, Kenneth. Peer Effects in the Diffusion of Solar Photovoltaic Panels. *Marketing Science*, 31(6):900–912, November 2012. ISSN 0732-2399. doi: 10.1287/mksc.1120.0727. Publisher: INFORMS.

Bonan, Jacopo, Cattaneo, Cristina, d'Adda, Giovanna, and Tavoni, Massimo. The interaction of descriptive and injunctive social norms in promoting energy conservation. *Nature Energy*, 5(11):900–909, November 2020. ISSN 2058-7546. doi: 10.1038/s41560-020-00719-z. Number: 11 Publisher: Nature Publishing Group.

Bonan, Jacopo, Cattaneo, Cristina, d'Adda, Giovanna, and Tavoni, Massimo. Can social information programs be more effective? the role of environmental identity for energy conservation. *Journal of Environmental Economics and Management*, 108:102467, 2021. ISSN 0095-0696. doi: https://doi.org/10.1016/j.jeem.2021.102467.

Bordalo, Pedro, Gennaioli, Nicola, and Shleifer, Andrei. Salience. *Annual Review of Economics*, 14(1): 521–544, 2022. doi: 10.1146/annurev-economics-051520-011616.

Borick, Christopher P. and Rabe, Barry G. Personal Experience, Extreme Weather Events, and Perceptions of Climate Change, March 2017. ISBN: 9780190228620.

Brechin, Steven R. and Bhandari, Medani. Perceptions of climate change worldwide. *WIREs Climate Change*, 2(6):871–885, 2011. ISSN 1757-7799. doi: 10.1002/wcc.146. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/wcc.146.

Brosch, Tobias. Affect and emotions as drivers of climate change perception and action: a review. *Current Opinion in Behavioral Sciences*, 42:15–21, December 2021. ISSN 2352-1546. doi: 10.1016/j.cobeha.2021.02.001.

Brulle, Robert J., Carmichael, Jason, and Jenkins, J. Craig. Shifting public opinion on climate change: an empirical assessment of factors influencing concern over climate change in the U.S., 2002–2010. *Climatic Change*, 114(2):169–188, September 2012. ISSN 1573-1480. doi: 10.1007/s10584-012-0403-y.

Campante, Filipe, Durante, Ruben, and Tesei, Andrea. Media and Social Capital. *Annual Review of Economics*, 14(1):69–91, 2022. doi: 10.1146/annurev-economics-083121-050914. _eprint: https://doi.org/10.1146/annurev-economics-083121-050914.

Capstick, Stuart, Whitmarsh, Lorraine, Poortinga, Wouter, Pidgeon, Nick, and Upham, Paul. International trends in public perceptions of climate change over the past quarter century. *WIREs Climate Change*, 6 (1):35–61, 2015a. doi: https://doi.org/10.1002/wcc.321.

Capstick, Stuart, Whitmarsh, Lorraine, Poortinga, Wouter, Pidgeon, Nick, and Upham, Paul. International trends in public perceptions of climate change over the past quarter century. *WIREs Climate Change*, 6 (1):35–61, 2015b. doi: https://doi.org/10.1002/wcc.321.

Carvalho, Anabela. Media(ted)discourses and climate change: a focus on political subjectivity and (dis)engagement. *WIREs Climate Change*, 1(2):172–179, 2010. ISSN 1757-7799. doi: 10.1002/wcc.13. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/wcc.13.

Chen, Yubo, Ghosh, Mrinal, Liu, Yong, and Zhao, Liang. Media Coverage of Climate Change and Sustainable Product Consumption: Evidence from the Hybrid Vehicle Market. *Journal of Marketing Research*, 56(6):995–1011, 2019. ISSN 0022-2437, `https://www.jstor.org/stable/26967283`. Publisher: [Sage Publications, Inc., American Marketing Association].

Csereklyei, Zsuzsanna. Price and income elasticities of residential and industrial electricity demand in the european union. *Energy Policy*, 137:111079, 2020. ISSN 0301-4215. doi: https://doi.org/10.1016/j.enpol.2019.111079.

Duijndam, Sem and van Beukering, Pieter. Understanding public concern about climate change in europe, 2008–2017: the influence of economic factors and right-wing populism. *Climate Policy*, 21(3):353–367, 2021. doi: 10.1080/14693062.2020.1831431.

Egan, Patrick J. and Mullin, Megan. Local weather and climate concern. *Nature Climate Change*, 4(2): 89–90, February 2014. ISSN 1758-6798. doi: 10.1038/nclimate2104. Number: 2 Publisher: Nature Publishing Group.

Greenstone, Michael, Kopits, Elizabeth, and Wolverton, Ann. Developing a social cost of carbon for us regulatory analysis: A methodology and interpretation. *Review of Environmental Economics and Policy*, 7:23–46, 01 2013. doi: 10.1093/reep/res015.

Harth, Nicole Syringa, Leach, Colin Wayne, and Kessler, Thomas. Guilt, anger, and pride about in-group environmental behaviour: Different emotions predict distinct intentions. *Journal of Environmental Psychology*, 34:18–26, June 2013. ISSN 0272-4944. doi: 10.1016/j.jenvp.2012.12.005.

Hazlett, Chad and Mildenberger, Matto. Wildfire Exposure Increases Pro-Environment Voting within Democratic but Not Republican Areas. *American Political Science Review*, 114(4):1359–1365, November 2020. ISSN 0003-0554, 1537-5943. doi: 10.1017/S0003055420000441. Publisher: Cambridge University Press.

Hoffmann, Roman, Muttarak, Raya, Peisker, Jonas, and Stanig, Piero. Climate change experiences raise environmental concerns and promote Green voting. *Nature Climate Change*, 12(2):148–155, February 2022. ISSN 1758-6798. doi: 10.1038/s41558-021-01263-8. Number: 2 Publisher: Nature Publishing Group.

Howe, Peter D. Extreme weather experience and climate change opinion. *Current Opinion in Behavioral Sciences*, 42:127–131, December 2021. ISSN 2352-1546. doi: 10.1016/j.cobeha.2021.05.005.

Howe, Peter D., Marlon, Jennifer R., Mildenberger, Matto, and Shield, Brittany S. How will climate change shape climate opinion? *Environmental Research Letters*, 14(11):113001, October 2019. ISSN 1748-9326. doi: 10.1088/1748-9326/ab466a. Publisher: IOP Publishing.

Hughes, Llewelyn, Konisky, David M., and Potter, Sandra. Extreme weather and climate opinion: evidence from Australia. *Climatic Change*, 163(2):723–743, November 2020. ISSN 0165-0009, 1573-1480. doi: 10.1007/s10584-020-02900-5.

IEA. Global status report for buildings and construction 2019. Technical report, IEA, Paris, 2019, `https://www.iea.org/reports/global-status-report-for-buildings-and-construction-2019,License:CCBY4.0`.

ISPRA. Dissesto idrogeologico in italia: pericolosità e indicatori di rischio. Rapporti 287/2018, Istituto Superiore per la Protezione e la Ricerca Ambientale, 2018, `https://www.isprambiente.gov.it/it/pubblicazioni/rapporti/dissesto-idrogeologico-in-italia-pericolosita-e-indicatori-di-rischio-edizi`

Jones, Rory V., Fuertes, Alba, and Lomas, Kevin J. The socio-economic, dwelling and appliance related factors affecting electricity consumption in domestic buildings. *Renewable and Sustainable Energy Reviews*, 43:901–917, March 2015. ISSN 1364-0321. doi: 10.1016/j.rser.2014.11.084.

McCoy, Shawn J and Walsh, Randall P. Wildfire risk, salience & housing demand. *Journal of Environmental Economics and Management*, 91:203–228, 2018.

Moser, Susanne C. Communicating climate change: history, challenges, process and future directions. *WIREs Climate Change*, 1(1):31–53, 2010. ISSN 1757-7799. doi: 10.1002/wcc.11. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/wcc.11.

Muñoz Sabater, J. ERA5-Land monthly averaged data from 1981 to present. Copernicus Climate Change Service (C3S) Climate Data Store (CDS), 2019.

Mundaca, Luis and Samahita, Margaret. What drives home solar pv uptake? subsidies, peer effects and visibility in sweden. *Energy Research Social Science*, 60:101319, 2020. ISSN 2214-6296. doi: https://doi.org/10.1016/j.erss.2019.101319.

Nannicini, Tommaso, Stella, Andrea, Tabellini, Guido, and Troiano, Ugo. Social capital and political accountability. *American Economic Journal: Economic Policy*, 5(2):222–50, May 2013. doi: 10.1257/pol.5.2.222.

Ogunbode, Charles A., Demski, Christina, Capstick, Stuart B., and Sposato, Robert G. Attribution matters: Revisiting the link between extreme weather experience and climate change mitigation responses. *Global Environmental Change*, 54:31–39, January 2019. ISSN 0959-3780. doi: 10.1016/j.gloenvcha.2018.11.005.

Ojala, Maria, Cunsolo, Ashlee, Ogunbode, Charles A., and Middleton, Jacqueline. Anxiety, worry, and grief in a time of environmental and climate crisis: A narrative review. *Annual Review of Environment and Resources*, 46(1):35–58, 2021. doi: 10.1146/annurev-environ-012220-022716.

Pianta, Silvia and Sisco, Matthew R. A hot topic in hot times: how media coverage of climate change is affected by temperature abnormalities. *Environmental Research Letters*, 15(11):114038, November 2020. ISSN 1748-9326. doi: 10.1088/1748-9326/abb732. Publisher: IOP Publishing.

Saari, Ulla A., Damberg, Svenja, Frömbling, Lena, and Ringle, Christian M. Sustainable consumption behavior of Europeans: The influence of environmental knowledge and risk perception on environmental concern and behavioral intention. *Ecological Economics*, 189:107155, November 2021. ISSN 0921-8009. doi: 10.1016/j.ecolecon.2021.107155.

Sampei, Yuki and Aoyagi-Usui, Midori. Mass-media coverage, its influence on public awareness of climate-change issues, and implications for japan's national campaign to reduce greenhouse gas emissions. *Global Environmental Change*, 19(2):203–212, 2009. ISSN 0959-3780. doi: https://doi.org/10.1016/j.gloenvcha.2008.10.005. Traditional Peoples and Climate Change.

Schmidt, Andreas, Ivanova, Ana, and Schäfer, Mike S. Media attention for climate change around the world: A comparative analysis of newspaper coverage in 27 countries. *Global Environmental Change*, 23(5):1233–1248, 2013. ISSN 0959-3780. doi: https://doi.org/10.1016/j.gloenvcha.2013.07.020.

Schneider, Claudia R, Zaval, Lisa, and Markowitz, Ezra M. Positive emotions and climate change. *Current Opinion in Behavioral Sciences*, 42:114–120, December 2021. ISSN 2352-1546. doi: 10.1016/j.cobeha.2021.04.009.

Schwartz, Daniel and Loewenstein, George. The Chill of the Moment: Emotions and Proenvironmental Behavior. *Journal of Public Policy & Marketing*, 36(2):255–268, September 2017. ISSN 0743-9156. doi: 10.1509/jppm.16.132. Publisher: SAGE Publications Inc.

Sisco, Matthew R., Bosetti, Valentina, and Weber, Elke U. When do extreme weather events generate attention to climate change? *Climatic Change*, 143(1):227–241, July 2017. ISSN 1573-1480. doi: 10.1007/s10584-017-1984-2.

Sisco, Matthew R., Pianta, Silvia, Weber, Elke U., and Bosetti, Valentina. Global climate marches sharply raise attention to climate change: Analysis of climate search behavior in 46 countries. *Journal of Environmental Psychology*, 75:101596, June 2021. ISSN 0272-4944. doi: 10.1016/j.jenvp.2021.101596.

Staiger, Douglas and Stock, James H. Instrumental variables regression with weak instruments. *Econometrica*, 65(3):557–586, 1997. ISSN 00129682, 14680262, `http://www.jstor.org/stable/2171753`.

Stanley, Samantha K., Hogg, Teaghan L., Leviston, Zoe, and Walker, Iain. From anger to action: Differential impacts of eco-anxiety, eco-depression, and eco-anger on climate action and wellbeing. *The Journal of Climate Change and Health*, 1:100003, March 2021. ISSN 2667-2782. doi: 10.1016/j.joclim.2021.100003.

Steg, Linda and Vlek, Charles. Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology*, 29(3):309–317, September 2009. ISSN 0272-4944. doi: 10.1016/j.jenvp.2008.10.004.

Steinberger, Ralf, Pouliquen, Bruno, and van der Goot, Erik. An introduction to the Europe Media Monitor family of applications, September 2013. arXiv:1309.5290 [cs].

Stoddard, Isak, Anderson, Kevin, Capstick, Stuart, Carton, Wim, Depledge, Joanna, Facer, Keri, Gough, Clair, Hache, Frederic, Hoolohan, Claire, Hultman, Martin, Hällström, Niclas, Kartha, Sivan, Klinsky, Sonja, Kuchler, Magdalena, Lövbrand, Eva, Nasiritousi, Naghmeh, Newell, Peter, Peters, Glen P., Sokona, Youba, Stirling, Andy, Stilwell, Matthew, Spash, Clive L., and Williams, Mariama. Three Decades of Climate Mitigation: Why Haven't We Bent the Global Emissions Curve? *Annual Review of Environment and Resources*, 46(1):653–689, 2021. doi: 10.1146/annurev-environ-012220-011104. _eprint: https://doi.org/10.1146/annurev-environ-012220-011104.

van der Werff, Ellen, Steg, Linda, and Keizer, Kees. The value of environmental self-identity: The relationship between biospheric values, environmental self-identity and environmental preferences, intentions and behaviour. *Journal of Environmental Psychology*, 34:55–63, 2013. ISSN 0272-4944. doi: https://doi.org/10.1016/j.jenvp.2012.12.006.

Williams, Hywel T. P., McMurray, James R., Kurz, Tim, and Hugo Lambert, F. Network analysis reveals open forums and echo chambers in social media discussions of climate change. *Global Environmental Change*, 32:126–138, May 2015. ISSN 0959-3780. doi: 10.1016/j.gloenvcha.2015.03.006.

Xie, Belinda, Brewer, Marilynn B., Hayes, Brett K., McDonald, Rachel I., and Newell, Ben R. Predicting climate change risk perception and willingness to act. *Journal of Environmental Psychology*, 65:101331, October 2019. ISSN 0272-4944. doi: 10.1016/j.jenvp.2019.101331.

Yanovitzky, Itzhak and Stryker, Jo. Mass media, social norms, and health promotion efforts: A longitudinal study of media effects on youth binge drinking. *Communication Research*, 28(2):208–239, 2001. doi: 10.1177/009365001028002004.

Zaval, Lisa, Keenan, Elizabeth A., Johnson, Eric J., and Weber, Elke U. How warm days increase belief in global warming. *Nature Climate Change*, 4(2):143–147, February 2014. ISSN 1758-6798. doi: 10.1038/nclimate2093. Number: 2 Publisher: Nature Publishing Group.

Zhuravskaya, Ekaterina, Petrova, Maria, and Enikolopov, Ruben. Political Effects of the Internet and Social Media. *Annual Review of Economics*, 12(1):415–438, 2020. doi: 10.1146/annurev-economics-081919-050239. _eprint: https://doi.org/10.1146/annurev-economics-081919-050239.

Notes

[1] Specifically, we employ “a” (with spaces, which is a common Italian preposition) as a neutral keyword. To avoid retrieving excessive tweets that include the neutral term, we restrict this latter search to the week beginning on the first Monday of each month. To reduce noise, we apply a Hodrick-Presckott filter to the provincial time series.

[2] We use the ArcGIS REST APIs (`developers.arcgis.com`).

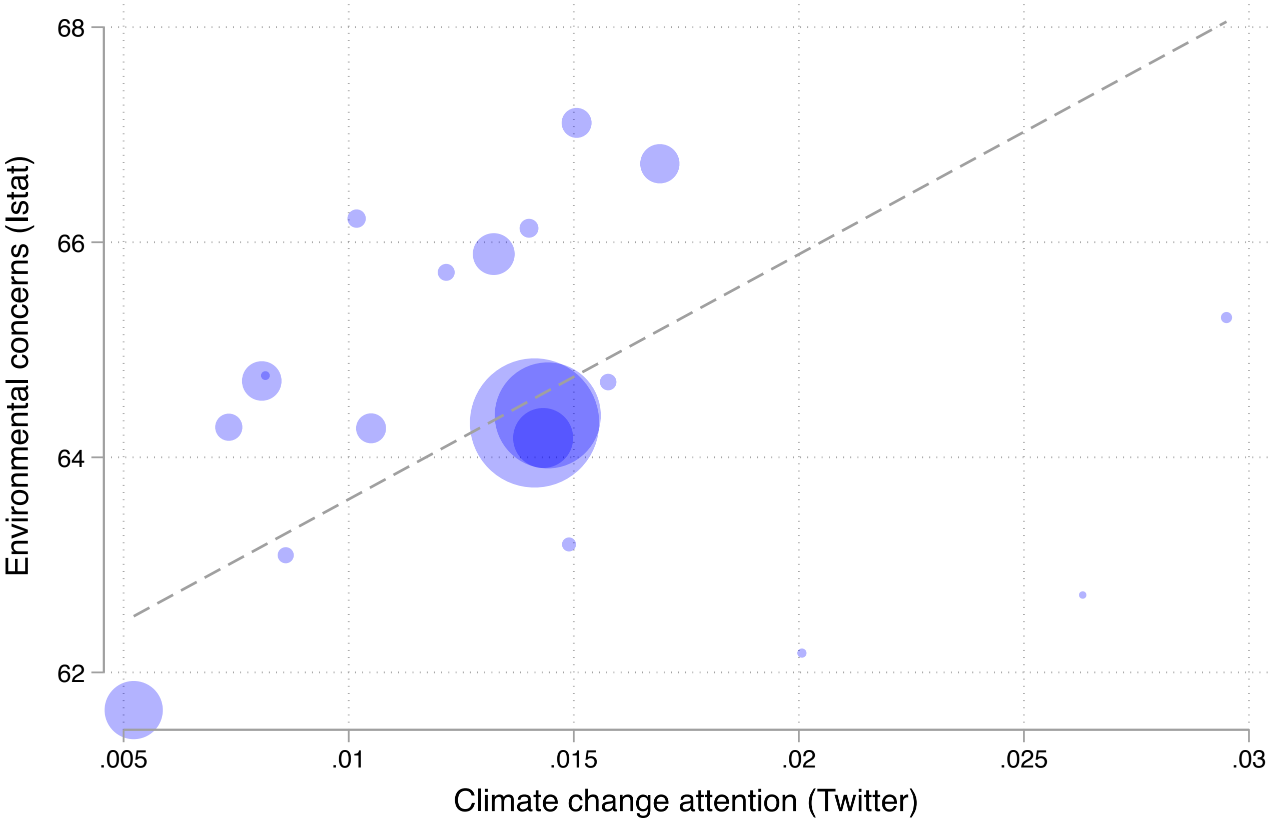
[3] Data on Italian news are collected and gathered by the Europe Media Monitor (Steinberger et al., 2013).

[4] Appendix Figure A.6 displays the evolution of raw monthly average daily consumption over time in our sample and the series after controlling for seasonality (net of month-of-the-year fixed effects).

[5] Data are available at `map.fridaysforfuture.org`.

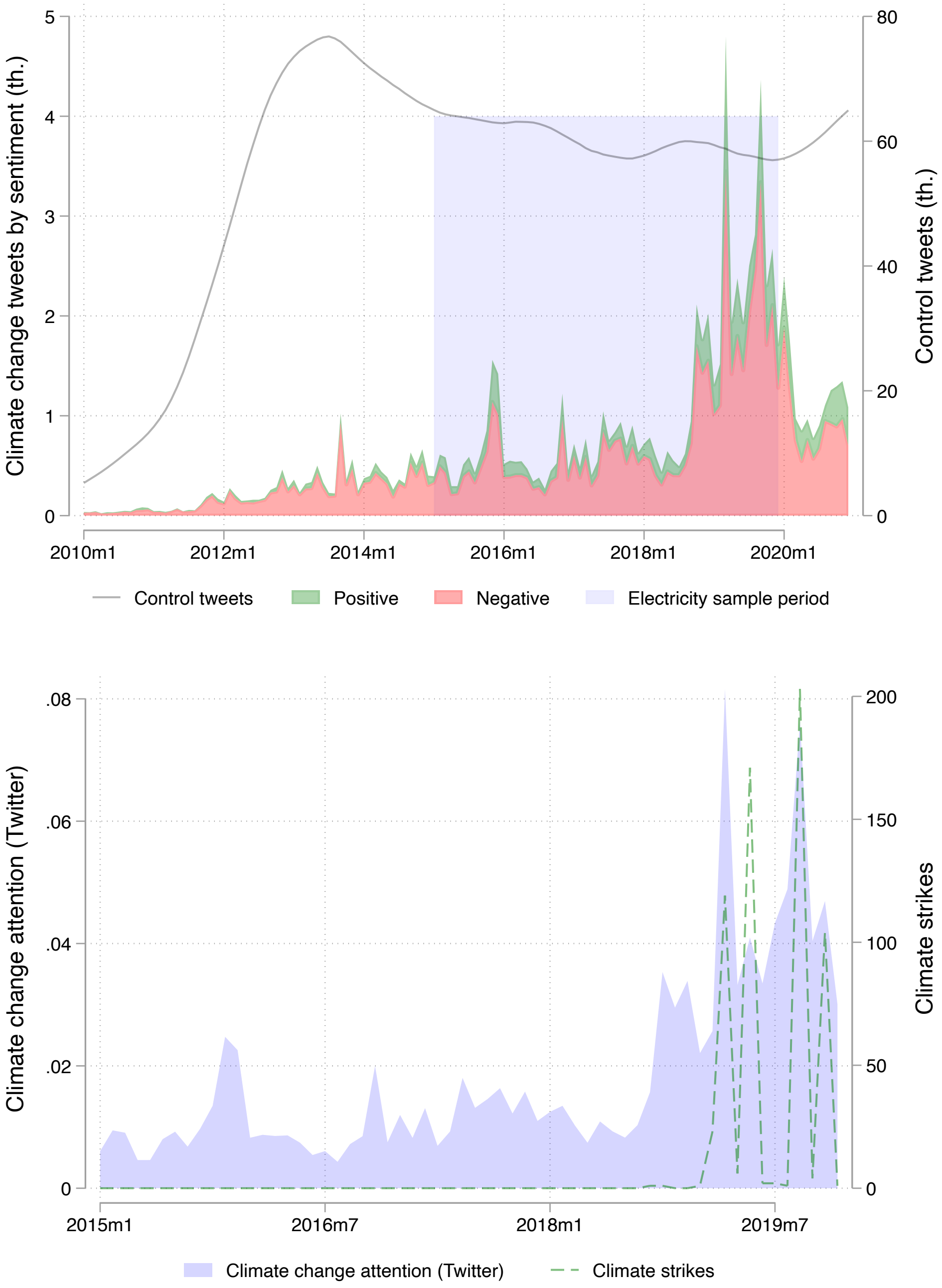
[6] F-stats$>$ 10 are typically considered acceptable (Staiger and Stock, 1997).

Tables and Figures



Notes: The figure displays a scatter plot of the index of social media attention to climate change (horizontal axis) and the index of environmental concern (vertical axis) aggregated at the regional level and a population-weighted linear interpolation. Dots are Italian regions (*N* = 20), and the size is proportional to the population. The environmental concern index is defined as the share of individuals listing climate change among their top environmental concerns (Preoccupazione per i cambiamenti climatici, Aspetti della Vita Quotidiana, ISTAT, `https://www.istat.it/it/archivio/284910`).

Figure 1: Social Media Attention to Climate Change and Environmental Concerns



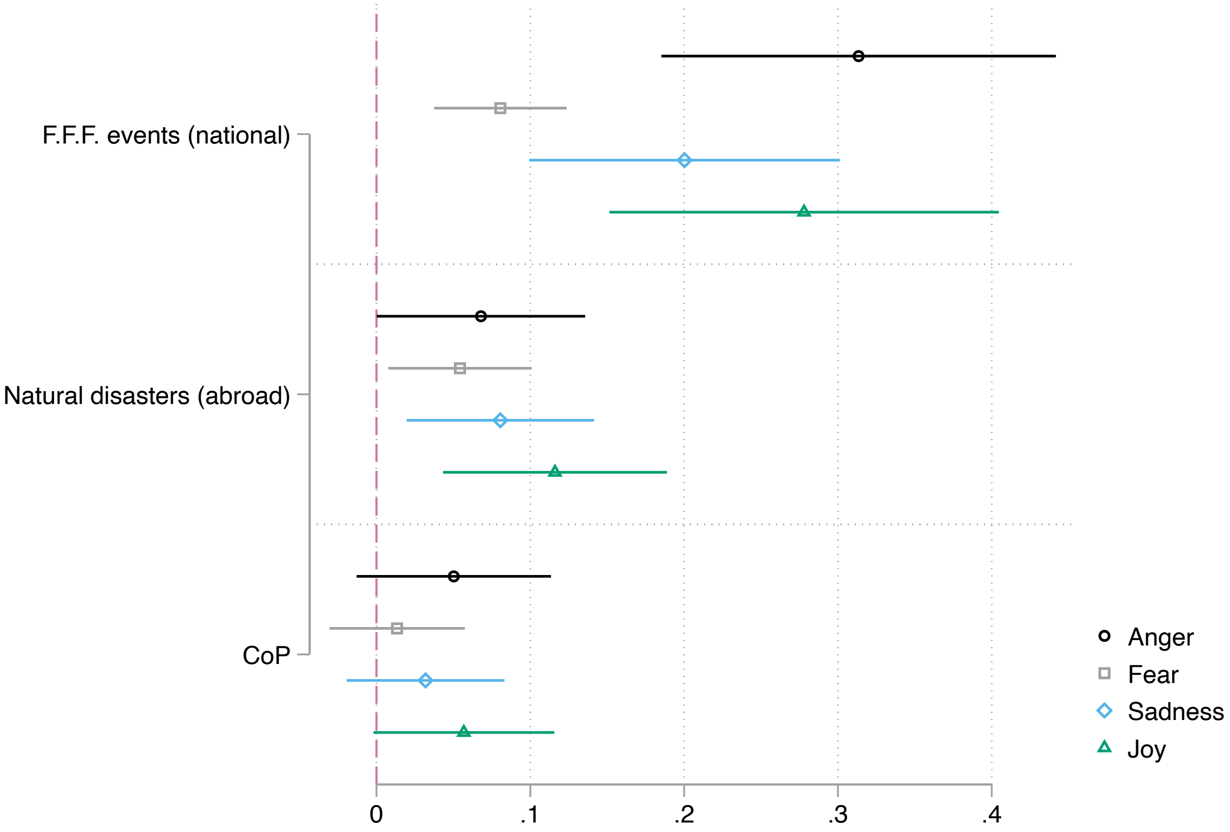
Notes: The top panel shows the number of climate change tweets (mentioning "climate change" or "global warming") by sentiment (positive in green, negative in red) on the left axis and the number of control tweets, or the index of Twitter activity, (right axis) between January 2010 and December 2020, both in thousands. The shaded area indicates the study period (when the electricity usage data are available (January 2015–December 2019)). The bottom panel shows the social media climate change attention index (the number of climate change tweets divided by the index of Twitter activity) on the left axis and the number of climate strikes organized in Italy in the month on the right axis in the study period.

Figure 2: Social Media Attention to Climate Change by Sentiment and Twitter Activity Over Time

Table 1: Sociopolitical and Climatic Determinants of Climate Change Salience

	(1)	(2)	(3)	(4)
	Social Media Attention to Climate Change			
Climate strikes (national)	0.288***	0.287***	0.287***	0.285***
	(0.073)	(0.060)	(0.058)	(0.060)
Natural disasters (abroad)	0.074**	0.099***	0.099***	0.100***
	(0.034)	(0.035)	(0.036)	(0.036)
CoP	0.060**	0.050	0.049	0.049
	(0.027)	(0.032)	(0.031)	(0.032)
Observations	12,832	12,832	12,832	12,832
Provinces	107	107	107	107
Province F.E.	Y	Y	-	-
Quadratic time trend	Y	Y	Y	-
Temperature F.E.	Y	Y	Y	Y
Month-of-year F.E.	-	Y	-	-
Month-of-year by Prov. F.E.	-	-	Y	Y
Provincial quadratic time trend	-	-	-	Y

Notes: The unit of observation is a province-month. The study period is from January 2015 to December 2019. The dependent variable is the index of social media attention to climate change. The independent variables are the monthly number of climate strikes in Italy, the monthly number of natural disasters outside Italy, and whether a CoP is organized in the month. All variables are measured in standard deviations. The model progressively adds controls, as indicated in the bottom part of the table. Observations are weighted by the provincial-month level of Twitter activity. Robust standard errors, clustered at the provincial and monthly levels, are in parentheses. *** p<0.01, ** p<0.05, * p<0.1



Notes: The figure shows the estimated effects of sociopolitical and climatic events on social media attention to climate change by emotion. This is done in separate regressions where all dependent variables have been standardized separately on their corresponding standard deviations. Appendix Table A.2 reports regression results.

Figure 3: Effect of Sociopolitical and Climatic Events on Social Media Attention to Climate Change by Emotion

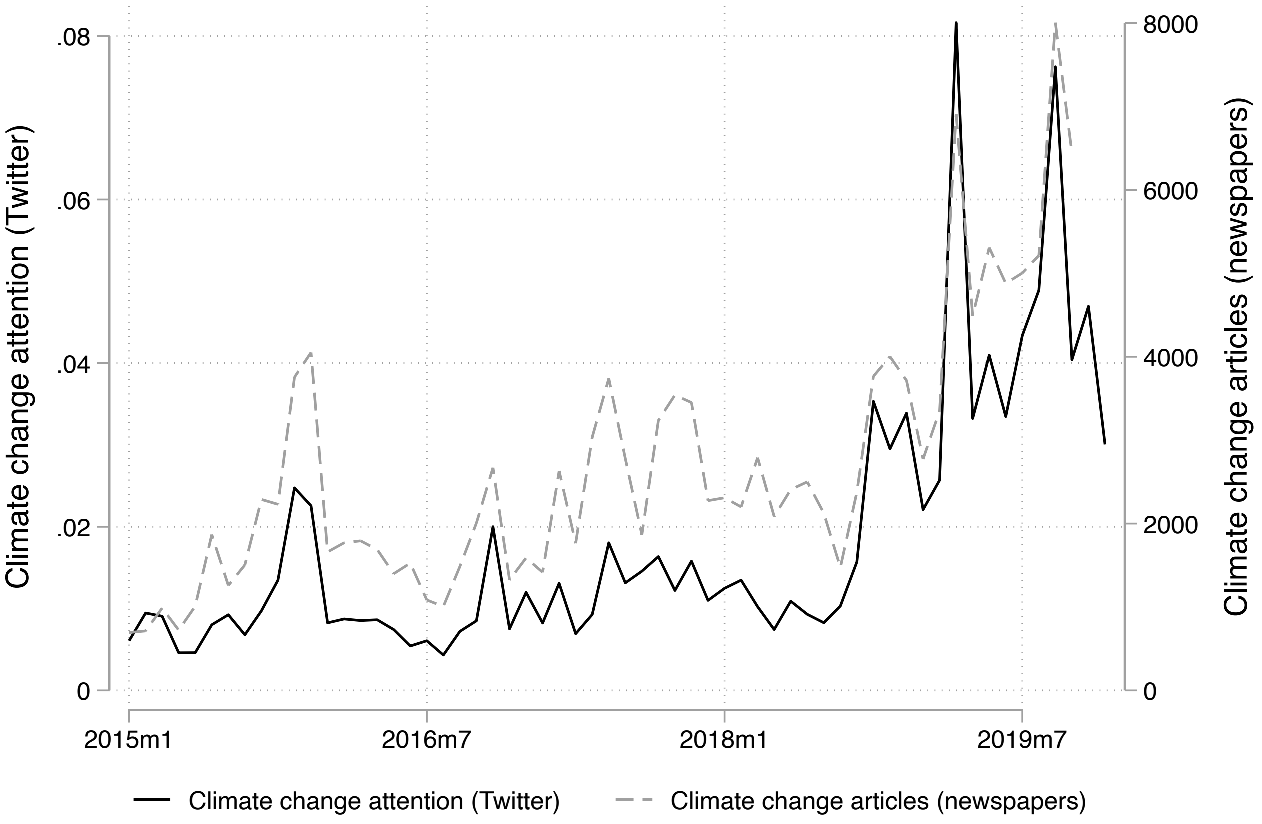
Table 2: Climate Change Salience and Electricity Consumption

	2SLS—Electricity Consumption (individual SD)			
Panel A	(1)	(2)	(3)	(4)
CC salience (t)	-0.046**	-0.038*	-0.038*	-0.052**
	(0.022)	(0.021)	(0.021)	(0.024)
CC salience (t-1)				-0.023
				(0.031)
CC salience (t-2)				0.012
				(0.027)
CC salience (t+1)				0.008
				(0.031)
Panel B	2SLS—Electricity Consumption (log)			
CC salience (t)	-0.011**	-0.008*	-0.008*	-0.011**
	(0.005)	(0.005)	(0.005)	(0.005)
CC salience (t-1)				-0.004
				(0.007)
CC salience (t-2)				0.002
				(0.006)
CC salience (t+1)				0.002
				(0.007)
Panel C	First stage—Social Media Attention to Climate Change (CC Salience)			
Climate strikes (national)	0.416***	0.421***	0.419***	-
	(0.093)	(0.091)	(0.092)	
Natural disasters (abroad)	0.134**	0.134**	0.136**	-
	(0.062)	(0.060)	(0.060)	
First stage F	10.8	11.9	11.6	-
Overidentification pval	.701	.574	.562	-
First stage F L2				17.9
First stage F L1				16.2
First stage F L0				7
First stage F F1				7.2
Observations	61,657,925	61,657,925	61,657,925	57,242,757
Users	1,476,438	1,476,438	1,476,438	1,424,914
Individual F.E.	Y	Y	Y	Y
Quadratic time trend	Y	Y	-	-
Temperature F.E.	Y	Y	Y	Y
Month-of-year F.E.	Y	-	-	-
Month-of-year by Prov. F.E.	-	Y	Y	Y
Provincial quadratic time trend	-	-	Y	Y

Notes: The unit of observation is the customer-month. The study period is from January 2015 to December 2019. Panels A and B display the 2SLS estimates, where the dependent variable is the monthly average electricity consumption in a day, in standard deviation or in logarithm. Panel C shows the first stage, where the dependent variable is the index of social media attention to climate change, expressed in standard deviations. The model progressively adds controls, as indicated in the bottom part of the table. Two months' lags and one month's lead are included in column 4. Robust standard errors, clustered at the provincial and monthly levels, are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

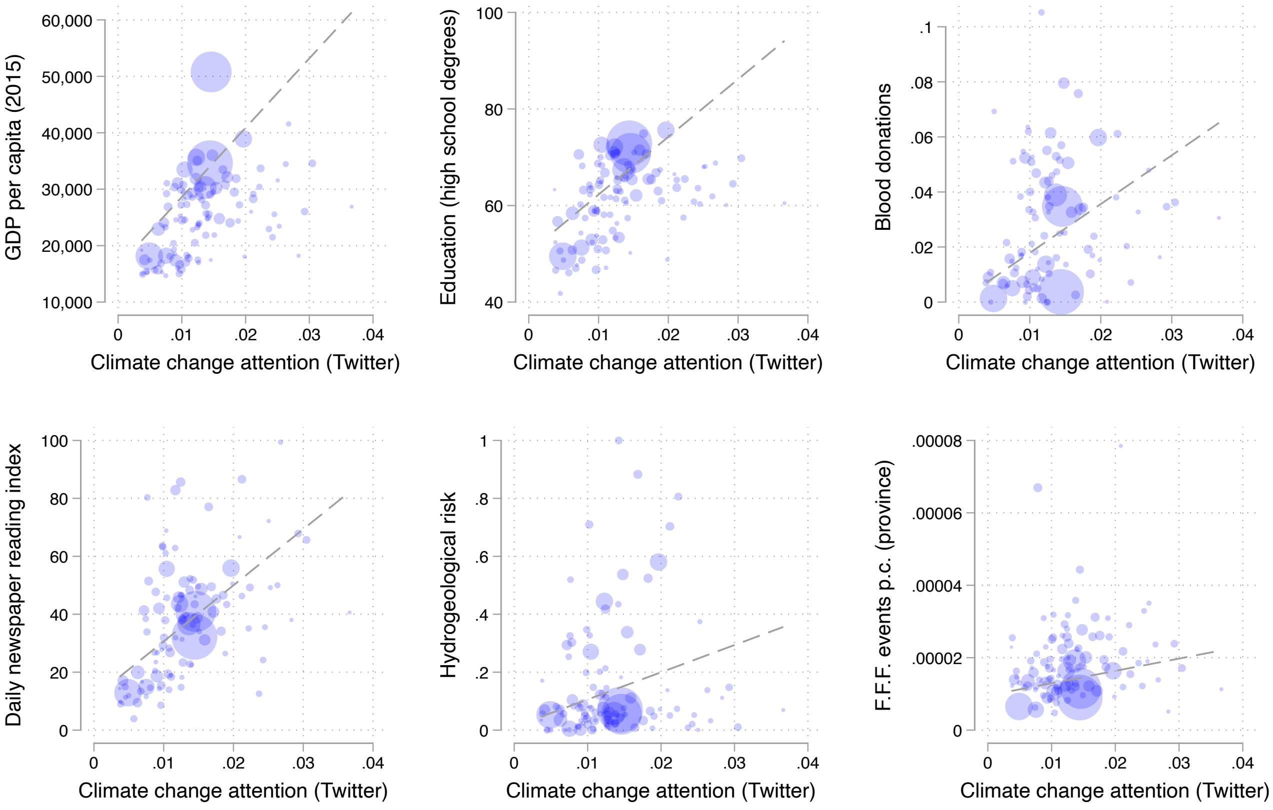
Appendix

A Additional Figures and Tables



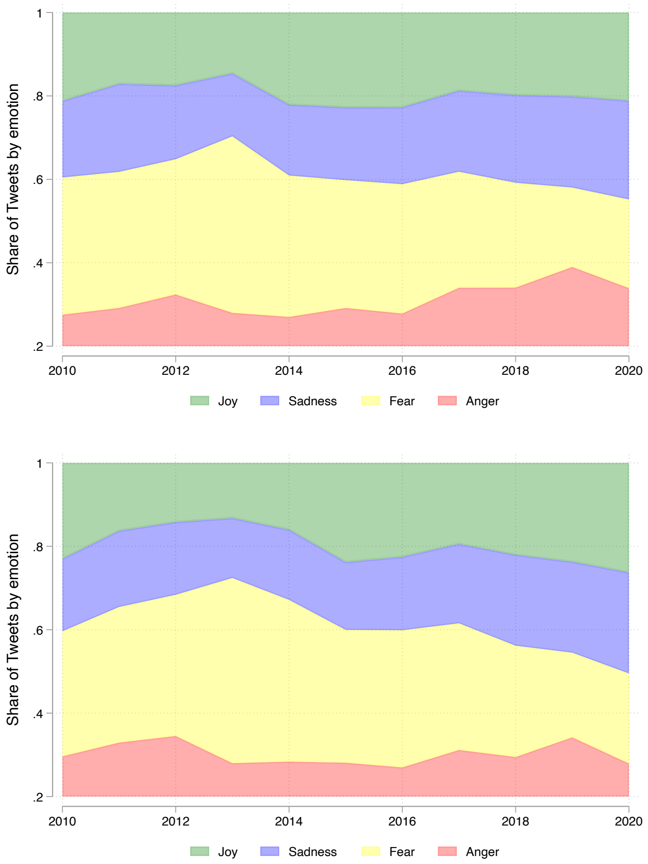
Notes: the figure displays the index of social media attention to climate change (from Twitter) on the left axis and the monthly number of newspaper articles mentioning the keywords "climate change" or "global warming" in Italy (Pianta and Sisco, 2020) on the right axis.

Figure A.1: Social Media Attention to Climate Change and Climate Change Prevalence in the News



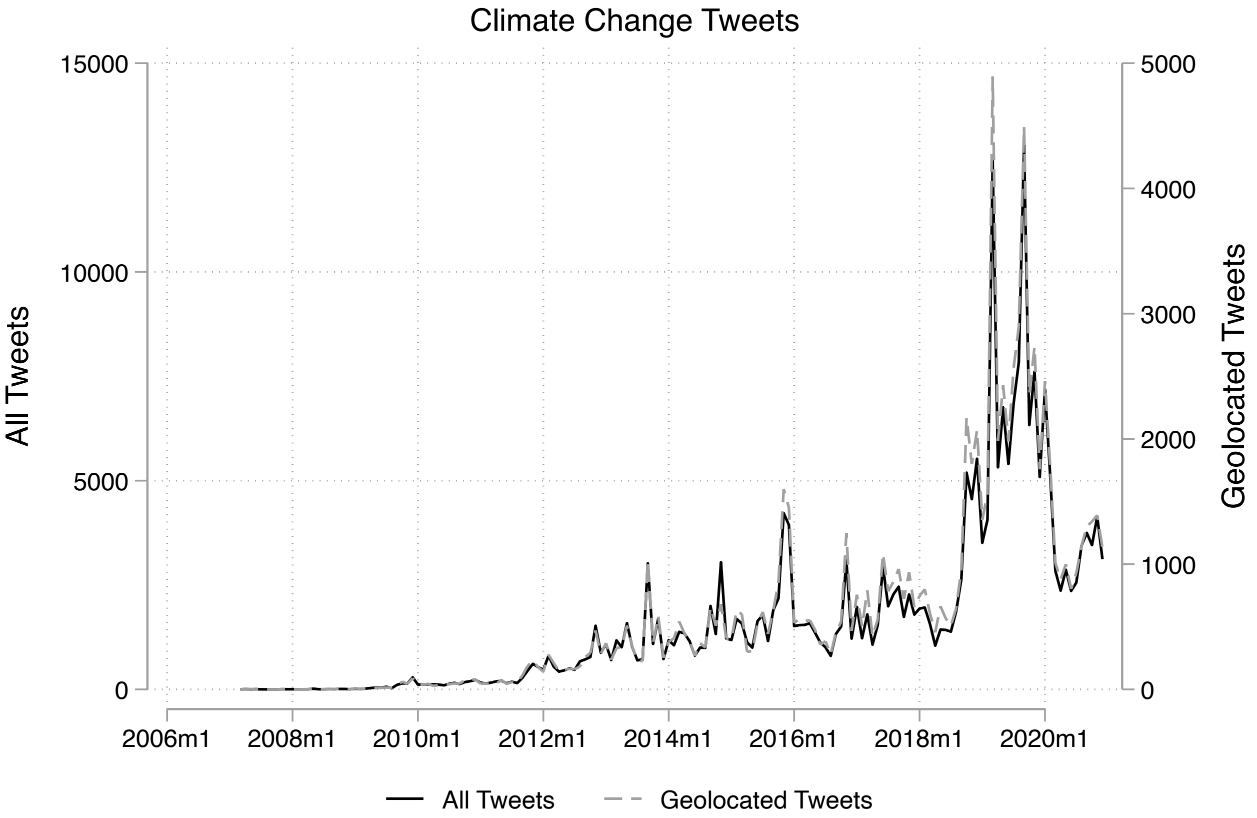
Notes: The figure displays a scatterplot of the index of social media attention to climate change (horizontal axis) and other variables (vertical axis) aggregated at the provincial level and the corresponding population-weighted linear interpolations. Dots are Italian provinces (*N* = 107), and the size is proportional to the population. GDP per capita is the 2015 gross domestic product at current market prices per capita, at the NUTS 3 level (i.e., provinces (Eurostat)). Education is the percentage of those 25–64 years old with a high school diploma in 2019, at the NUTS 3 level (BES-Istat). Blood donations and the daily newspaper reading index are the average per capita blood donations and the diffusion of nonsport newspapers per every 100 inhabitants in 2001–2002, at the NUTS 3 level ((Nannicini et al., 2013)). Population is the resident population in 2011, at the NUTS 3 level (Istat). Hydrogeological risk is defined as the share of the population in the municipality living in areas at medium or high hydrogeologic risk (ISPRA, 2018), which we aggregate at the NUTS 3 level.

Figure A.2: Climate Change Salience and Other Variables



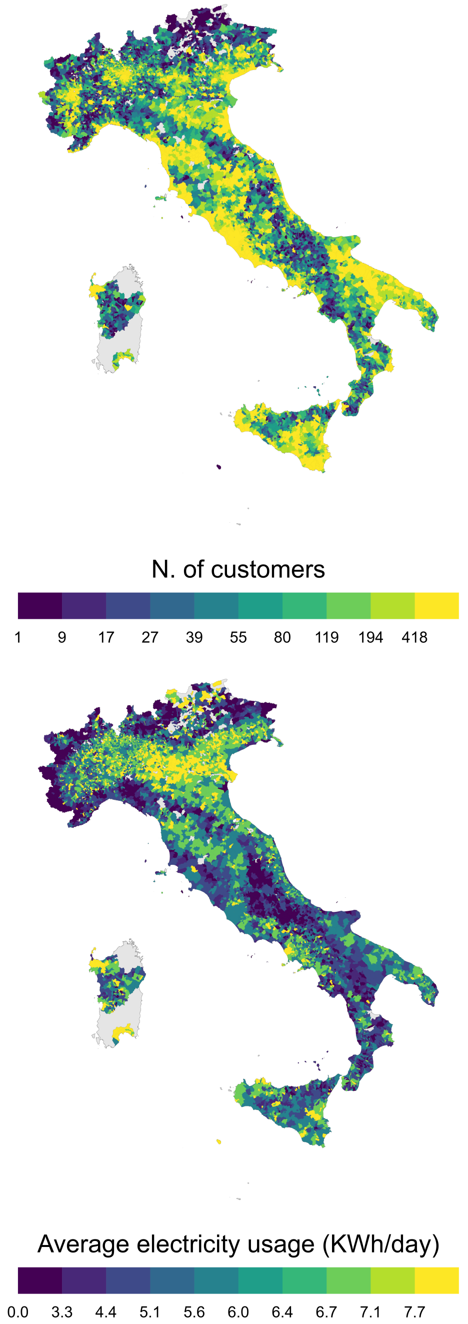
Notes: The figure shows the distribution of all Italian (top panel) and geolocated (bottom panel) climate change tweets, by emotions (joy in green, sadness in blue, fear in yellow, anger in red), obtained through content analysis, from January 2010 to December 2019. Geolocated tweets represent 32 percent of all Italian tweets.

Figure A.3: Distribution of Emotions in Climate Change Tweets



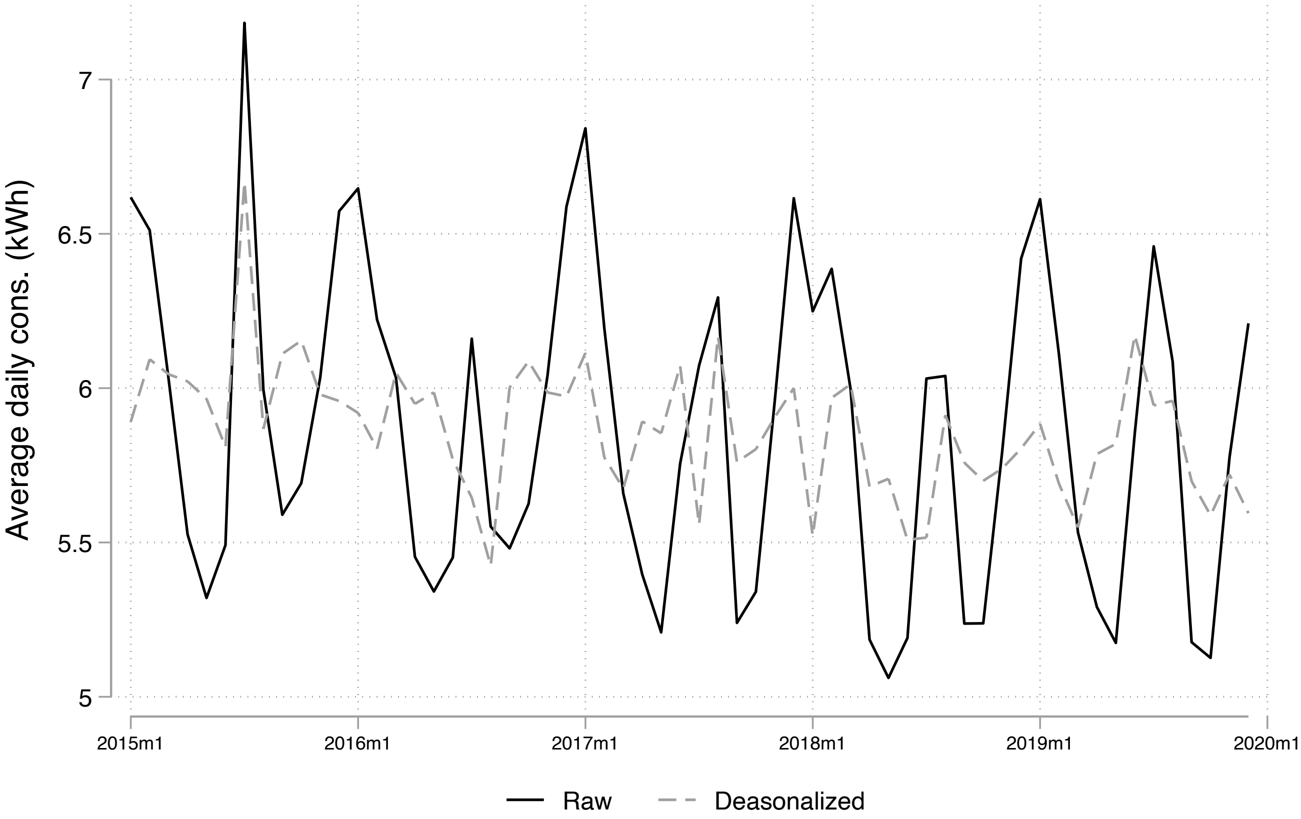
Notes: The figure displays the total climate change tweets (left axis) and those that we can geolocate at the provincial level.

Figure A.4: Total Italian Climate Change Tweets over Time



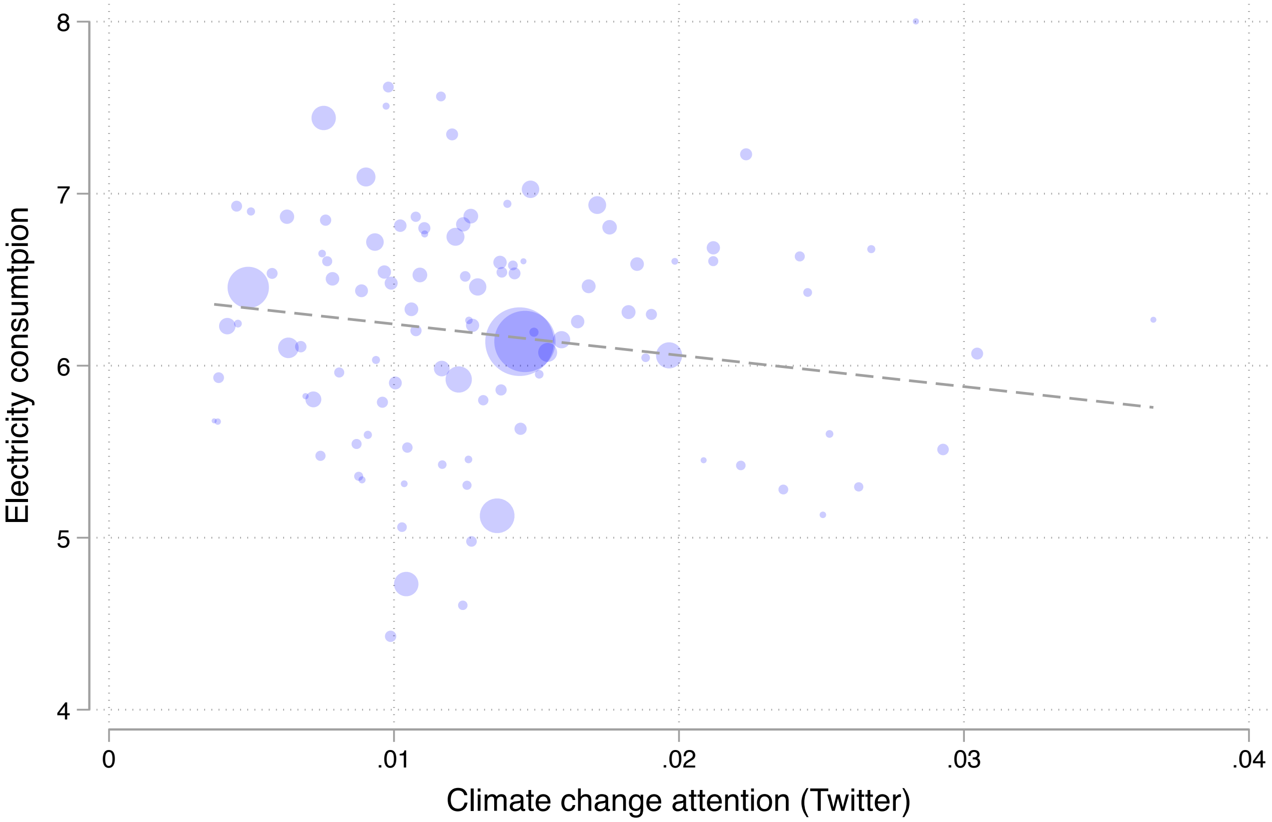
Notes: The maps show the distribution of customers (top panel) and the average daily electricity usage (bottom panel), in KWh/day, at the municipal level over the sample period (2015–2019). Scales report deciles of the distributions.

Figure A.5: Geographical Distribution of Customers and Electricity Consumption



Notes: The figure depicts the daily average electricity usage over the study period (solid line). The deseasonalized series (dashed line) is obtained by plotting the residual of a regression of the average daily consumption in a month on month-of-the-year fixed effects.

Figure A.6: Average Daily Electricity Consumption over Time



Notes: The figure displays a scatterplot of the index of social media attention to climate change (horizontal axis) and average daily electricity usage (vertical axis) aggregated at the provincial level and a population-weighted linear interpolation. Dots are Italian provinces (*N* = 107), and the size is proportional to the population.

Figure A.7: Average Consumption and Social Media Attention to Climate Change

Table A.1: Examples of Tweets by Emotion and Sentiment

Text (English translation)	Emotion	Sentiment
4 more degrees and we will all die suffocated #climate #globalwarming #greenhouseeffect	Fear	Negative
Live from CNR Bologna, epic conference on #globalwarming #anthropocene	Joy	Positive
There is little to do: when I was a child, these floods and floods did not exist!!! #GlobalWarming #Tropicalization #Weather #BadWeather	Anger	Negative
Look, having 30°C on October 25th is not normal at all. I am not happy about it. #globalwarming	Sadness	Negative

Table A.2: Sociopolitical and Climatic Determinants of Climate Change Salience by Emotion

	(1) Anger	(2) Fear	(3) Sad	(4) Joy
Climate strikes (national)	0.313***	0.081***	0.200***	0.278***
	(0.065)	(0.022)	(0.051)	(0.064)
Natural disasters (abroad)	0.068**	0.054**	0.081**	0.116***
	(0.034)	(0.024)	(0.031)	(0.037)
CoP	0.050	0.013	0.032	0.057*
	(0.032)	(0.022)	(0.026)	(0.030)
Observations	12,832	12,832	12,832	12,832
Provinces	107	107	107	107
Temperature F.E.	Y	Y	Y	Y
Month-of-year by Prov. F.E.	Y	Y	Y	Y
Provincial quadratic time trend	Y	Y	Y	Y

Notes: The unit of observation is a province-month. The study period is January 2015–December 2019. The dependent variable is the index of social media attention to climate change by emotion (the number of climate change tweets classified with that emotion over Twitter activity). The independent variables are the monthly number of climate strikes in Italy, the monthly number of natural disasters outside Italy, and whether a CoP occurs in the month. All variables are measured in standard deviations. The model includes controls, indicated in the bottom part of the table. Observations are weighted by the provincial-month level of Twitter activity. Robust standard errors, clustered at the provincial and monthly levels, are in parentheses. The coefficients of interest are plotted in Table 3. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table A.3: Sensitivity Analysis: Different IVs

	2SLS—Electricity Consumption				
Panel A	(1)	(2)	(3)	(4)	(5)
CC salience	-0.038*	-0.039*	-0.041**	-0.042*	-0.045**
	(0.021)	(0.021)	(0.017)	(0.021)	(0.017)
Panel B	First stage—Social Media Attention to Climate Change				
Climate strikes (national)	0.416***	0.427***		0.442***	
	(0.092)	(0.092)		(0.099)	
Natural disasters (abroad)	0.136**	0.133**	0.117**		
	(0.060)	(0.058)	(0.057)		
CoPs		0.302			
		(0.220)			
Climate strikes (abroad)			0.445***		0.469***
			(0.093)		(0.102)
First stage F	11.6	8.73	12.1	19.98	21.24
Overidentification pval	.562	.721	.526	-	-
Observations	61,657,925	61,657,925	61,657,925	61,657,925	61,657,925
Users	1476438	1476438	1476438	1476438	1476438
Individual F.E.	Y	Y	Y	Y	Y
Temperature F.E.	Y	Y	Y	Y	Y
Month-of-year by Prov. F.E.	Y	Y	Y	Y	Y
Provincial quadratic time trend	Y	Y	Y	Y	Y

Notes: The table replicates our main estimates using different combinations of instrumental variables. The unit of observation is the customer-month. The study period is January 2015–December 2019. Panel A displays 2SLS estimates, where the dependent variable is the monthly average electricity consumption in a day. Panel B shows the first stage of these estimates, where the dependent variable is the index of social media attention to climate change. All variables are measured in standard deviations. The model includes controls, as indicated in the bottom part of the table. Robust standard errors, clustered at the provincial and monthly levels, are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table A.4: Heterogenous Effects Analysis

	Consumption		Age		Gender		Soc. capital (munic.)		Income (munic.)		CC salience (prov.)	
	Low	High	59-	60+	Female	Male	Low	High	Low	High	Low	High
Panel A	2SLS—Electricity Consumption											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
CC salience	-0.034**	-0.042	-0.038*	-0.038*	-0.037*	-0.038*	-0.045*	-0.030*	-0.056**	-0.024	-0.039*	-0.035*
	(0.017)	(0.025)	(0.022)	(0.020)	(0.021)	(0.021)	(0.026)	(0.017)	(0.026)	(0.018)	(0.022)	(0.020)
Panel B	First stage—Social Media Attention to Climate Change											
Climate strikes (national)	0.420***	0.417***	0.418***	0.419***	0.419***	0.418***	0.422***	0.444***	0.405***	0.440***	0.391***	0.519***
	(0.092)	(0.093)	(0.093)	(0.092)	(0.091)	(0.094)	(0.085)	(0.104)	(0.087)	(0.100)	(0.080)	(0.139)
Natural disasters	0.137**	0.136**	0.138**	0.134**	0.133**	0.139**	0.119**	0.155**	0.125**	0.147**	0.136***	0.131
	(0.060)	(0.059)	(0.061)	(0.059)	(0.059)	(0.060)	(0.054)	(0.067)	(0.057)	(0.065)	(0.053)	(0.093)
First stage F	11.67	11.56	11.49	11.73	11.98	11.37	14.45	10.3	11.89	11.14	14.68	7.23
Overidentification pval	.658	.501	.489	.686	.54	.576	.599	.512	.614	.492	.462	.985
Mean cons.	3.88	8.20	6.36	5.77	5.85	6.27	6.22	5.92	6.38	5.87	6.07	6.15
SD cons.	1.73	2.77	3.18	3.13	3.13	3.19	3.18	3.16	3.23	3.11	3.17	3.18
Users	736,769	739,669	816,056	660,326	627,589	848,849	764,811	661,932	609,616	817,337	1,124,956	351,482
Individual F.E.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Temperature F.E.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Month-of-year by Prov. F.E.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Provincial quadratic time trend	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes: The unit of observation is a province-month. The study period is January 2015–December 2019. Panel A displays 2SLS estimates, where the dependent variable is the monthly average electricity consumption in a day, standardized at the individual level. Panel B shows the first stage of these estimates, where the dependent variable is the index of social media attention to climate change. Models are estimated on the subsamples indicated in the headings. Consumption refers to the household, age and gender refer to the contract holder, social capital and income are measured at the municipal level, and climate change salience is measured at the province level. "High" and "Low" indicate levels above and below the median. All variables are measured in standard deviations. The model includes controls, as indicated in the bottom part of the table. Robust standard errors, clustered at the provincial and monthly levels, are in parentheses. *** p<0.01, ** p<0.05, * p<0.1