# Heat Exposure and Heterogeneities in Climate Change Attitudes and Green Voting in Europe

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[PRELIMINARY: PLEASE DO NOT CIRCULATE]

**Abstract**

In this paper we study how exposure to extreme weather episodes affects attitudes towards climate change and voting for green parties. Combining information on local temperatures with a nationally representative survey across 28 European countries and two decades, we construct measures of extreme temperature exposure in the weeks before voting in national elections. We find that extreme warm spells affect both attitudes towards climate change and green voting behavior. If interviewed in a region exposed to heat waves, individuals become more concerned with climate change and feel stronger responsibility to act against it. If the heat waves occur before a national elections, individuals in warmer regions are more likely to vote for green parties and for coalitions that include green parties. Exploiting a rich set of individual characteristics, we show that the effects on both attitudes and green voting are stronger for the highly educated.

# 1 Introduction

In the past two decades, there has been a rise in awareness and concern for environmental issues across Europe, thanks partly to recent climate movements and media coverage. Understanding the drivers of changes in public concern and support for Green parties is important to identify the mechanisms underlying transformations towards a greener economy and more sustainable society (Hoffmann et al. 2022).

In this paper we provide novel evidence linking temperature data to detailed individual survey data for 28 European countries between 2002 and 2021. Using individual survey data has three key advantages. First, knowing the time of elections and the time of interviews we can precisely calculate the individual exposure to extreme weathers, exploiting therefore both time and spatial variation for identification. Specifically, we exploit the fact that before being interviewed or voting for national elections, individuals from the same country but different regions are exposed to varying weather conditions. Second, we can use different types of outcomes both for climate attitudes, such as whether individuals feel responsible for climate change and whether they are worried about climate change, and for green voting, such as whether they voted for greens or green coalitions. Third, we can explore the heterogeneity of our baseline effects along a wide range of individual characteristics, such as education, social class, migration background and political engagement. To the best of our knowledge, this is the first study to investigate how exposure to extreme temperatures affect green voting of different population subgroups cross-nationally.

We find that exposure to extremely warm weather conditions before being interviewed in the European Social Survey positively affects concerns about climate change, as proxied by whether individuals feel responsible and are worried about climate change. Additionally, we find that exposure to heat waves before national elections increases the probability of voting for green parties and coalitions that include green parties. Our baseline results are robust to different measures of extreme weather, as well as different intensities of extreme weather.

Exploiting the rich set of individual demographic characteristics, we also find that education significantly mediates the effect of extreme weather on green voting. Highly educated individuals are more likely to vote for green parties if exposed to extreme weather as compared to lower educated. We find no differences in the effects between women and men.

# 2 Data

## 2.1 European Social Survey

To explore the effects of extreme weather on green attitudes and green voting among Europeans, we use data from the European Social Survey (ESS). The ESS was launched in 2002. Since then, more than 470,000 respondents from 38 countries have been interviewed in person and asked a battery of questions about their attitudes, behaviors, and values, as well as a about a wide set of demographic characteristics. Importantly, the ESS also contains information about the region[1] and date of the interview. For the green attitudes we use three variables: whether individuals feel responsible for climate change and whether they are worried about climate change. For voting behaviors, we start from the question about the party voted in the last national election. We then assigned to each party in each national election a dummy variable with value 1 if the party presented itself as a green party alone or in coalition with other parties.

## 2.2 Temperature data

Measures of temperature extremes are based on daily means from the ERA5-Land reanalysis (Hersbach et al. 2020). The 0.1° grid cells are aggregated to NUTS regions as their mean, weighted with the fraction each cell intersects with the region area. The measures are then defined based on the distribution of daily values in region $i$ and calender week $w$ in the reference periods which characterize the regional climate. Reference periods are constructed as 10 years rolling windows.

Temperatures variables are calculated based on degrees in excess of extreme percentiles of the weekly distribution. Warm (cold) spells are defined as at least three consecutive days with temperatures $T_{it}^{\text{spell}}$ that fall above (below) a the 90th, 95th, or 97.5th (10th, 5th, 2.5th) percentile $\tau_{iw}^{y-y_{-10}}$.

The positive excess temperature is defined as

[1]Not all countries have the same level of detail. Some countries have NUTS2 regions, while others have NUTS3. Moreover, some countries change their regional aggregations across time. We aggregate our weather data to the regional level based on the ESS aggregation for each country and year.

$$
\mathrm{T}_{it}^{\text{excess,warm}} =
\begin{cases}
T_{it}^{\text{spell}} - \tau_{iw}^{y-y_{-10}}, & \text{if } T_{it}^{\text{spell}} > \tau_{iw}^{y-y_{-10}} \\
0, & \text{otherwise}
\end{cases}
\tag{1}
$$

and the negative excess temperature as

$$
\mathrm{T}_{it}^{\text{excess,cold}} =
\begin{cases}
\mid T_{it}^{\text{spell}} - \tau_{iw}^{y-y_{-10}} \mid, & \text{if } T_{it}^{\text{spell}} < \tau_{iw}^{y-y_{-10}} \\
0, & \text{otherwise}
\end{cases}
\tag{2}
$$

so that higher values of both cold and warm spell measures indicate more extreme events. The daily values are then summed up to weekly values and averaged over rolling 4-week periods, 24 week periods and 52 week periods. Weather data are then attached to the each individual respondent through the interview date and region, or the election date and region.

# 3 Empirical strategy

To estimate the effects of extreme weather on green attitudes and green voting, we exploit the variation in the occurrence of repeated heat waves across space (region) and time (date of election or date of interview). To isolate the effects of extreme weather, we want to exclude characteristics of the political system as well as regional characteristics which might be potentially correlated with green voting. We therefore include both country x year (of interview or national election) fixed effects and region fixed effects.

We estimate the following baseline models:

$$I_{i,c,y,r} = \beta ExtremeWarm_{c,y,r} + \gamma X_i + \delta \lambda_{c,y} + \mu_r + \epsilon_{i,o,y,m,f} \quad (3)$$

where I is the individual outcome, either green attitudes or green voting, ExtremeWarm is the extreme weather conditions, X is a set of individual characteristics, $\lambda_{c,y}$ are country x year fixed effects and $\mu_r$ are region fixed effects, $\epsilon_{i,o,y,m,f}$ is the error term. Stardard errors are clustered at the region x round of ESS survey.

# 4 Baseline results

In this section we present the baseline results for the effects of extreme weather exposure on green attitudes and green voting. Each table in this sections reports the results for extreme weather (warm and cold) in terms of both excess number of days or excess degrees and includes different windows of exposure (4, 24, or 52 weeks before being interviewed or before the last national election).

## 4.1 Extreme Temperatures and Green Attitudes

Tables 1 and 2 report the results for the effects of exposure to extreme cold and extreme warm weather on personal responsibility and worries about climate change. We find that exposure to extremely warm weather increases the probability of feeling strongly responsible for climate change by 1.3 and 0.5 percentage points respectively for extreme warm days and extreme warm temperatures in the 4 weeks before the interview. We find larger - albeit not significant effects - for larger exposure windows. The same extreme weather exposures have stronger effects on being worried about climate change. Individuals interviewed in regions with abnormal warm weather are more likely to feeling worried about climate change. The effect becomes larger with more weeks of exposure, reaching 5.5 and 2.8 percentage points respectively for extreme warm days and extreme warm temperatures in the 52 weeks before the interview.

Our results - based on the last three waves of the ESS - provide initial evidence that individuals change their attitudes towards climate change in response to the extreme weather, and specifically to extremely warm weather. In the next section, we investi-

gate whether these change in attitudes also traslate into more votes for green parties in national elections.

Table 1: Effects of extreme temperatures on feeling responsible for climate change

| | Within 4 weeks | | Within 24 weeks | | Within 52 weeks | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Extreme cold (days) | -0.005 | | 0.010 | | 0.023 | |
| | (0.004) | | (0.015) | | (0.030) | |
| Extreme warm (days) | 0.013*** | | 0.032 | | 0.031 | |
| | (0.004) | | (0.022) | | (0.022) | |
| Extreme cold (C°) | | -0.001 | | 0.003 | | 0.012 |
| | | (0.002) | | (0.007) | | (0.015) |
| Extreme warm (C°) | | 0.005** | | 0.009 | | 0.020 |
| | | (0.002) | | (0.013) | | (0.014) |
| $N$ | 76111 | 76111 | 76111 | 76111 | 76111 | 76111 |
| $R^2$ | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |
| Mean of outcome | 0.49 | 0.49 | 0.49 | 0.49 | 0.49 | 0.49 |
| SD of outcome | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |

**Note:** Outcome is Feel personal responsibility for CC (binary). Individual controls include: age, migration background, years of education, gender. Fixed effects: Country by interview year, election month, NUTS. Standard errors clustered at the NUTS x interview year level. Significance levels are indicated by $*<.1$, ** $<.05$, *** $<.01$.

## 4.2 Extreme Weather and Green Voting

Table **??** reports the results of exposure to extreme cold and extreme warm weather on green voting, where green voting includes both votes casted exclusively to green parties or to coalitions with green parties. We find that sizable effects of extreme warm weather on voting for a green party of a coalition that includes a green party. These effects are increasing with the time of exposure and are consistent across different exposure measures (excess days or temperatures). One excess day of heat wave in the year before national elections increases by 3.3 percentage points the probability of voting for green parties or green coalitions. We find similar effects for excess temperatures.

Table 2: Effects of extreme temperatures on worries about climate change

| | Within 4 weeks | | Within 24 weeks | | Within 52 weeks | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Extreme cold (days) | -0.007* | | -0.025 | | -0.093*** | |
| | (0.004) | | (0.017) | | (0.030) | |
| Extreme warm (days) | 0.011*** | | -0.009 | | 0.055** | |
| | (0.004) | | (0.018) | | (0.023) | |
| Extreme cold (C°) | | -0.003* | | -0.012 | | -0.041*** |
| | | (0.002) | | (0.007) | | (0.014) |
| Extreme warm (C°) | | 0.006*** | | -0.015 | | 0.028** |
| | | (0.002) | | (0.011) | | (0.014) |
| $N$ | 77033 | 77033 | 77033 | 77033 | 77033 | 77033 |
| $R^2$ | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Mean of outcome | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 |
| SD of outcome | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |

**Note:** Outcome is Worried about CC (binary). Individual controls include: age, migration background, years of education, gender. Fixed effects: Country by interview year, election month, NUTS. Standard errors clustered at the NUTS x interview year level. Significance levels are indicated by $*<.1$, $**<.05$, $***<.01$.

# 5 Heterogeneous Responses to Extreme Temperatures

In this section we present results for the heterogeneous responses to extreme weather conditions on green voting, focusing on the effects of heat waves. Table 4 reports results for heterogeneous effects by educational level, where the baseline category is low educated. We find that the effects for extremely warm weather increase with the level of education. For the 52 weeks exposure, the effects are 3.2 and 2.1 percentage points larger (for extreme days and extreme temperatures respectively) relative to the effects for low educated individuals. Table 5 we show results by gender, where the baseline group is male. We find strong positive effects for men, and only small and mostly insignificant differences with women. While education seems to play a crucial role in determining the size of the effect of extreme weather on green voting, gender has secondary role. As the research is still on-going, in the near future we will include also heterogeneities by age group, migration background and political engagement.

Table 3: Effects of extreme weather on green voting

| | Within 4 weeks | | Within 24 weeks | | Within 52 weeks | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Extreme cold (days) | -0.006 | | -0.008 | | -0.018 | |
| | (0.005) | | (0.009) | | (0.014) | |
| Extreme warm (days) | 0.006* | | 0.024*** | | 0.033** | |
| | (0.004) | | (0.008) | | (0.014) | |
| Extreme cold (C°) | | -0.002 | | -0.007 | | -0.009* |
| | | (0.002) | | (0.004) | | (0.005) |
| Extreme warm (C°) | | 0.006** | | 0.010** | | 0.021*** |
| | | (0.002) | | (0.004) | | (0.007) |
| $N$ | 244373 | 244373 | 244373 | 244373 | 244373 | 244373 |
| $R^2$ | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 |
| Mean of outcome | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |
| SD of outcome | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 |

**Note:** Outcome is Coalition with green party - only with valid party code. Individual controls include: age, migration background, years of education, gender. Fixed effects: Country by election year, election month, NUTS. Standard errors clustered at the NUTS x election year level. Significance levels are indicated by $* < .1$, $** < .05$, $*** < .01$.

Table 4: Effects of extreme temperatures on green voting by education

| | Within 4 weeks | | Within 24 weeks | | Within 52 weeks | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Extreme warm (days) | 0.008** | | 0.008 | | 0.018 | |
| | (0.004) | | (0.007) | | (0.013) | |
| Middle educated | -0.003 | | 0.018*** | | 0.018*** | |
| | (0.003) | | (0.004) | | (0.007) | |
| Highly educated | -0.009 | | 0.034*** | | 0.032*** | |
| | (0.006) | | (0.008) | | (0.012) | |
| Extreme warm (C°) | | 0.006*** | | -0.000 | | 0.011 |
| | | (0.002) | | (0.004) | | (0.007) |
| Middle educated | | -0.000 | | 0.011*** | | 0.012*** |
| | | (0.002) | | (0.002) | | (0.003) |
| Highly educated | | -0.005* | | 0.020*** | | 0.021*** |
| | | (0.003) | | (0.004) | | (0.006) |
| $N$ | 281381 | 281381 | 281381 | 281381 | 281381 | 281381 |
| $R^2$ | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 |
| Mean of outcome | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| SD of outcome | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |

**Note:** Outcome is Coalition with green party - all voters. Reference category for edu_3cat is low educated (less than 12 years of schooling). Individual controls include: age, migration background, years of education, gender. Fixed effects: Country by election year, election month, NUTS.Standard errors clustered at the NUTS x election year level. Significance levels are indicated by $*<.1$, $**<.05$, $***<.01$.

Table 5: Effects of extreme temperatures on green voting by gender

| | Within 4 weeks | | Within 24 weeks | | Within 52 weeks | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Extreme warm (days) | 0.007** | | 0.023*** | | 0.027** | |
| | (0.003) | | (0.007) | | (0.013) | |
| Female | -0.004 | | -0.000 | | 0.007 | |
| | (0.003) | | (0.004) | | (0.005) | |
| Extreme warm (C°) | | 0.007*** | | 0.009** | | 0.017*** |
| | | (0.002) | | (0.004) | | (0.007) |
| Female | | -0.003** | | 0.001 | | 0.005** |
| | | (0.001) | | (0.002) | | (0.003) |
| $N$ | 281381 | 281381 | 281381 | 281381 | 281381 | 281381 |
| $R^2$ | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 |
| Mean of outcome | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| SD of outcome | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |

**Note:** Outcome is Coalition with green party - all voters. Reference category for gndr is Female. Individual controls include: age, migration background, years of education. Fixed effects: Country by election year, election month, NUTS.Standard errors clustered at the NUTS x election year level. Significance levels are indicated by $* < .1$, ** $< .05$, *** $< .01$.

# References

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