Temperature and Decision Making:
Evidence from Australian Elections[†]

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Abstract

We show that elevated temperatures on election days induce vote-switching between political parties in elections separate from the effect of temperature on voter turnout. We develop a novel panel dataset, combining rich data on Australian federal elections held between 2004 and 2022 with interpolated daily temperature data and detailed census data. Using this, under our preferred specification which includes polling-place and election-year fixed effects, we find that at the average polling place, a 5.1°C increase in temperature induces 6.5% of swing voters to switch their first-preference vote to another party. This result is robust to alternate specifications of temperature and a barrage of sensitivity tests. We additionally examine "non-voting" decisions related to voting and establish a causal link between elevated election-day temperatures and diminished cognitive performance in complex decision-making. These results are consistent with the existing literature and have significant implications for the outcomes of elections in preferential voting systems.

[†] **Statement of Originality**:
I hereby declare that this submission is my own work and to the best of my knowledge it contains no material previously published or written by another person. Nor does it contain any material which has been accepted for the award of any other degree or diploma at the University of Sydney or at any other educational institution, except where due acknowledgement is made in this thesis. Any contributions made to the research by others with whom I have had the benefit of working with at the University of Sydney is explicitly acknowledged. I also declare that the intellectual content of this study is the product of my own work and research, except to the extent that assistance from others in the project's conception and design is acknowledged.

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I Introduction

It is a well-established fact that temperatures are rising globally due to anthropogenic climate change (Calvin et al. 2023). In this context, it is important to better understand both the magnitude to which temperature impacts decision-making, and the mechanisms through which this takes place. One area where the effects of altered decision-making may be felt is in the outcomes of elections. Exogenous temperature shocks may induce swing voters (those indifferent between options) to place their votes at the ballot box differently than they would have absent a temperature shock (i.e., heatwave), altering the outcomes of elections, and in-turn potentially altering a range of policy outcomes (Liao & Junco 2022). Previous research into the impacts of weather on elections has primarily focused on how rain and snow impact voter turnout with little attention paid to the impact of temperature. Additionally, the one known study that examines the impact of temperature on elections does not separate the extensive margin decision of *'whether to vote'* - do I go and turnout to vote in an election?, - and the intensive margin decision of *'who to vote for'* - which party will I vote for on my ballot paper? (Van Assche et al. 2017).

In this context, we pose the following question: do random temperature shocks alter the decisions-making of voters when they are at the ballot box, and as such, influence the outcomes of democratic elections? We answer this question in the context of Australian federal elections - a case study which is uniquely suited for this research. Australia is one of few nations with routinely enforced compulsory voting, and as such, has consistently high voter turnout on election days[1]. As the decision to vote is based on whether the costs outweigh the benefits for the individual (Riker & Ordeshook 1968; Verba & Nie 1987; Rosenstone & Hansen 1993), the relatively small extra cost of voting on a hot day is likely to be outweighed by the large cost of the fine for not voting[2]. This implies that temperature does not impact voter turnout in Australian federal elections[3], a result which we empirically prove (see Section VI). As such, in Australian federal elections, we are able to isolate the impact that temperature has upon the intensive margin of voting - who an swing voter chooses to vote for. This second decision captures how an individual's perception of utility between multiple options (political parties) is altered by an exogenous temperature shock. For partisan voters, the utility differential between the options is large, and we do not find a significant effect - these voters have strong, well-established preferences. In contrast, "swing" voters are nearly indifferent to two or more political parties, and it is for these individuals which temperature is most likely to alter perceived utility. Australia has a large cohort of these indifferent (but active) voters, with 13.6% of voters reporting to have decided who they would vote for on election day itself during the 2022 Federal election (Biddle 2022). Separating turnout from voting decisions is crucial as turnout is not an isolated decision but is endogenously linked to voting outcomes at the ballot box - higher levels of turnout have been shown to increase the volatility of election results and skew the demographics of the electorate (Hansford & Gomez 2010).

[1] Voter turnout between 2001 and 2022 ranges from 90.5% to 95% (AEC 2023d). Comparatively, over the same time period, voter turnout in United States presidential elections has ranged from 50.3% to 62% (McDonald 2023).

[2] Fines are issued by the Australian Electoral Commission and range between AUD$20 to AUD$180 (AEC 2021).

[3] This assumption is reinforced by (Persson et al. 2014), which found that rain (a factor known to impact turnout significantly in the US) does not deter voter turnout in the Swedish electoral system, a system highly comparable in structure to the Australian federal electoral system.

I Introduction

Moreover, Australia is unique amongst nations with enforced compulsory voting as it is the only one with a landmass large enough to generate large differences in average temperatures on an election day[4]. For example, the average daily high temperature in June (Australia's coldest month) in Darwin is 31.1°C, whilst in Hobart the average daily high temperature in June is 12.1°C (BOM 2023a, 2023b). Additionally, Australian federal elections are not held on a fixed date but instead occur across seasons. This provides us with the variation in temperatures on election days that such an analysis requires. Finally, as Australia utilises an preferential voting system, voting in Australia is more complicated than in the United States (AEC 2022c). As voting in Australia represents a more complex set of decisions, there exists more scope for temperature to have larger impacts on decision-making in this context.

Our approach combines detailed daily temperature data and census data from across Australia with election data from 5,422 polling places over the last 7 federal elections to generate a rich new panel data set. We then apply a two-way fixed effects model to examine the impact that both absolute and relative daytime and overnight temperatures have on a range of decisions associated with voting. We additionally employ a swathe of robustness and sensitivity checks and cross compare results between the House of Representatives and the Senate[5].

We find that in non-voting decisions (decisions which are procedural to the act of voting), voters systematically make more mistakes on their ballots and choose cognitively simpler

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[4] Whilst Brazil is another geographically large country with compulsory voting, in practice, turnout rates in Brazil are systematically lower than in Australia and the fine for not voting is comparatively more modest (IFES 2022).

[5] These are the two chambers of government at the federal level in Australia.

options when experiencing hotter temperatures. We find that a one standard deviation increase in temperature from the monthly average at the average polling place (5.1°C) results in a 0.5% increase in the proportion of votes which are considered to be invalid and a 2% increase in ”donkey” voting - voting for candidates in the order they appear on the ballot. Moreover, in a novel result, we find that when temperatures are elevated, voters switch their votes between political parties with 6.5% of swing voters switching whom they vote for in response to a one standard deviation increase in temperature at the average polling place. We also find that elevated temperatures are associated with increased vote-shares for parties which are typically viewed as being pro-environment, whilst parties with a poorly established voter base perform worse when election days are hot.

Our findings are important for two reasons. Firstly, they contribute to the ever expanding body of research which finds that decision-making (and many other outcomes) are highly sensitive to the climate. Previous research has established that hotter temperatures increase the incidence of workplace accidents which are typically unrelated with heat (Ireland et al. 2023), increase violence amongst prison populations (Mukherjee & Sanders 2021), and decrease labour productivity and labour supply (Somanathan et al. 2021). Furthermore, adaptation to temperature shocks through technologies such as air conditioning do not appear to limit the impact of temperature on decision-making and cognition (Heyes & Saberian 2019; Graff Zivin et al. 2018). We establish that even for a decision which individuals should ostensibly have much prior information about, they are still sensitive to random day-to-day fluctuations in temperature. Whilst we do not seek to extend the implications of this finding beyond the scope of the analysis performed, the implications for everyday welfare losses under heat are obvious.

Secondly, we establish a causal link between temperature and voting outcomes. Democratic elections are often won and lost on very small margins. Our results imply that, when an election is close, temperature may serve as one of the decisive factors which ultimately determines the outcome of an election. The implications of these results diffuse both into the economic study of decision-making as well as into the realm of political science and electioneering.

The rest of this paper is structured as follows; in Section II, we outline the existing literature pertaining to the effects of heat on decision-making broadly, and examine the previously established interactions between other climatic variables and election outcomes. Section III provides a background on Australian federal elections and specifically outlines the mechanisms through which we expect temperature to influence the decision-making of voters. Section IV provides details of data collection and interpolation methods. Section V details the methodology of the analysis. Section VI presents the results and robustness checks. Section VII concludes.

II Literature

II.a Temperature, Physiology, & Decisions

Whilst not the primary focus of this research, it is worth discussing the corpus of research linking temperatures to altered cognition. Brain chemistry and functioning are known to be temperature sensitive (Deboer 1998; Hocking et al. 2001). Specifically, Hancock & Vasmatzidis (2003) highlights that cognitive performance (i.e., decision-making) is far more responsive to heat stress than to cold stress. Seppänen et al. (2006) conduct a meta-analysis of experiments analysing productivity in office environments and find the highest level of productivity being at 21.75°C, with performance decreasing by 9% when temperatures are 30°C. These findings draw a link between elevated relative temperatures and reduced cognitive performance.

On decision-making specifically, Carias et al. (2022) exploit variations in the dates of an Indonesian longitudinal survey to analyse how individual decision-making responds to temperature. Hotter relative temperatures - and hotter nights in particular - lead individuals to make more rational choice violations and become more impatient. This is theorised to come from a shift from system 2 thinking - deliberative, logical, calculated decision-making requiring an increased cognitive load - to system 1 thinking - impulsive, emotional, heuristic-based decision-making requiring a reduced cognitive load (Kahneman 2011)[6] - primarily through the channel of increased stresses on the brain from heat-induced nighttime disturbances. Cheema & Patrick (2012) perform an analysis of five laboratory studies of temperature on decision-making and find that under hotter temperatures; i) individuals are less likely to make difficult gambles, ii) less likely to choose innovative products, and iii) more likely to engage in heuristic processing.

Similar results are found in Heyes & Saberian (2019)[7], which finds that high outdoor temperatures cause more habit-based decision-making by judges in an indoor, climate controlled environment. Graff Zivin et al. (2018) finds that hot temperature shocks reduce cognitive performance in mathematical tasks. The primary channel through which

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[6] Essentially, system 1 thinking is unconscious thought whilst system 2 thinking is conscious thought. The mechanical difference between these two modes of thought is the cognitive load each requires.

[7] Note: this paper was subject to a correction which argues that the external validity of the original paper may be limited (Heyes & Saberian 2022).

temperature appears to influence decision-making in both cases is a shift from complex, innovative decision-making (system 1 thinking) to a reliance on habits and heuristics (system 2 thinking) as a result of increased cognitive load or stress. Additionally, both papers argue that climate-control (i.e., air conditioning) is ineffective in ameliorating the impacts that temperature has on decision-making and as such, outdoor temperatures impact cognitive function irrespective of whether an individual is in a climate controlled environment[8].

Temperature shocks are known to have a number of effects on individual outcomes generally. Extreme temperatures reduce labour productivity and increase absenteeism due to increased psychological costs imposed on workers (Somanathan et al. 2021), reduces per person income in the United States through lost productivity (Deryugina & Hsiang 2014), and increase instances of workers compensation claims, even for health events which are considered to be typically unrelated to outdoor temperatures (Ireland et al. 2023). Hotter temperatures are also known to be positively associated with aggressive moods (Baylis 2020), increased incidences of violence (Mukherjee & Sanders 2021), increased incidences of crime (Brunsdon et al. 2009; Ranson 2014; Heilmann et al. 2021; Cohen & Gonzalez 2024), and increased mortality rates (Deschênes & Greenstone 2011).

II.b Elections

A second body of literature considers the interaction between weather, turnout, and voting outcomes at the extensive and intensive margins. Hansford & Gomez (2010) examine data from U.S. presidential elections and observe that the decision *to vote* is not separate and

8 Polling places in Australia are often climate controlled, hence the relevance of these findings.

distinct from the decision of *who to vote for*. They find that higher turnout; i) changes the partisan composition of the voting electorate, ii) decreases the vote share of incumbent parties, and iii) increases the volatility of electoral outcomes. Thus, low levels of turnout are more likely to yield representational biases.

Gomez et al. (2007) find that both precipitation and snowfall significantly reduce voter turnout in the U.S., whilst Persson et al. (2014) finds no effect of precipitation on voter turnout in Sweden - a voting system similar to the Australian voting system. Persson proposes that in preferential voting systems[9] with high turnout (such as Australia), voters are less sensitive to minor increases in cost (such as rainfall or hot temperatures). Additionally, Fraga & Hersh (2011) find that in competitive races, voters are less sensitive to increased costs. As such, voters may differ in their voting calculus depending on the intensity of on-the-ground campaigning. In this context, in non-mandatory voting systems, relatively hot temperatures may or may not represent a significant increase in the cost of voting and thus alter voter turnout. This research contributes to the literature by providing an analysis of a mandatory voting system wherein voters are highly likely to be unresponsive to temperature at the extensive margin of voting. Effectively, we are able to remove the issue of endogeneity between the decision of *whether to vote* and the decision of *who to vote for*.

Additional non-temperature weather effects have been observed to impact voting decisions at the intensive margin. Bassi (2019) deploys an experimental method to assess the

[9] These are voting systems where voters list a number of candidates on their ballot paper according to their preferences (i.e., the candidate the prefer the most would be numbered 1, their next-most preferred numbered 2 and so on). This is in comparison to "first-past-the-post" voting systems where voters may only cast a ballot for their most preferred candidate.

impact of inclement weather (though not temperature) on the decision of who to vote for. Horiuchi & Kang (2018) find evidence of vote-switching between Republicans and Democrats in the U.S. in response to inclement weather. Both papers find that voters become more risk-averse in inclement weather and choose candidates perceived to be less risky - often candidates viewed to be conservative. Additionally, a number of papers have found that temperature makes environmental issues (and specifically climate-change) a salient issue in the minds of voters (Guber 2001; Egan & Mullin 2012; Herrnstadt & Muehlegger 2014) and lawmakers alike (Bromley-Trujillo et al. 2019), potentially altering voting behaviour at the ballot box.

Specifically examining the direct impacts of temperature on voting behaviour, Van Assche et al. (2017) examines how relative changes in temperature impact voter turnout and voting outcomes in U.S. presidential elections. Following Zillmann (2003), heat induces heightened arousal which may increase prosocial behaviour depending on the context. As voting is typically viewed to be a prosocial behaviour, hotter relative temperatures increase voter turnout. Further, Liao & Junco (2022) examine how extreme weather events (including extreme temperatures) impact US congressional elections and campaign financing. They find that elections become more competitive if the incumbent has an anti-environment voting record, revealing issue salience as a potential mechanism through which voting behaviour changes in response to hotter temperatures. Notably, to the best of our knowledge, there have been no studies examining the impact of temperature shocks on voting behaviour at the intensive margin alone[10]. This research aims to fill this gap in the literature.

[10] The decision of *who to vote for?* separate from the decision of *whether to vote?*

III Conceptual Framework

III.a Australian Federal Elections

Australia has a system of compulsory voting at the federal level. Voters must enrol to vote, and once they are enrolled, they must vote or face fines[11]. Crucially, compulsory voting is enforced, meaning not voting imposes real costs upon individuals whom are on the electoral roll. As a result, Australia has persistently high rates of turnout - between 90.5% and 95% over the previous 8 federal elections.

The Australian federal government is divided into two houses; the House of Representatives (the ”lower house”) and the Senate (the ”upper house”). Representatives in the ”lower house” are elected at the divisional level - a local geography divided up proportional to population[12], whilst Senators in the ”upper house” are elected at the state and territory level, and seats are not allocated proportional to population[13]. During a federal election, voters receive two ballots - one for the House of Representatives and one for the Senate. The voting systems between these two houses differ, and as such, so do the decisions that voters must make at the ballot box.

In the House of Representatives, representatives are elected using an ”instant run-off” sys-

[11] Fines are issued by the Australian Electoral Commission and range between AUD$20 to AUD$180 (AEC 2021).

[12] There were 151 electoral divisions for the House of Representatives in the 2022 Australian federal election. See AEC (2023a) for further information on the division and allocation of federal electoral divisions.

[13] Each state receives 12 senators, whilst each territory receives 2 senators regardless of the population of each state or territory. This is a comparable system to the United States Senate.

tem of proportional voting[14]. Figure 1 displays an example House of Representatives ballot paper. Voters must submit a complete list of preferences 1 through n for all candidates listed on the ballot paper. This system results in voters facing three decisions when voting on their House of Representatives ballot. In order: whether to submit a legitimate vote[15], whether to "donkey vote"[16], and how to allocate their preferences. These three decisions are separate and are individually tracked by the Australian Electoral Commission (AEC).

The Senate uses a different voting system called the "single transferable vote"[17]. Figure 2 displays an example Senate ballot paper. When voting in the Senate, a voter may choose between one of two voting options; "above-the-line" or "below-the-line" voting. If a voter chooses to vote "above-the-line", they must list preferences over a minimum of six *parties*. If a voter chooses to vote "below-the-line", they must list preferences over a minimum of twelve *individual candidates* [18][19]. Functionally, voting "below-the-line" is a significantly more complex decision which requires more prior knowledge. As such, a voter in the

[14] Simply, voters submit a list of preferences over candidates. After the initial count, the candidate with the fewest number of "first-preferences" is eliminated. "Second-preferences" are then allocated between the remaining candidates. This continues until there are only two remaining candidates - the "run-off". The candidate with the most "down-ballot" preferences wins the election. For more information, refer to (AEC 2022c).

[15] This is known as "informal voting". For example, ballots that do not contain a full list of preferences over all candidates are considered to be "informal" and are discarded from the vote count.

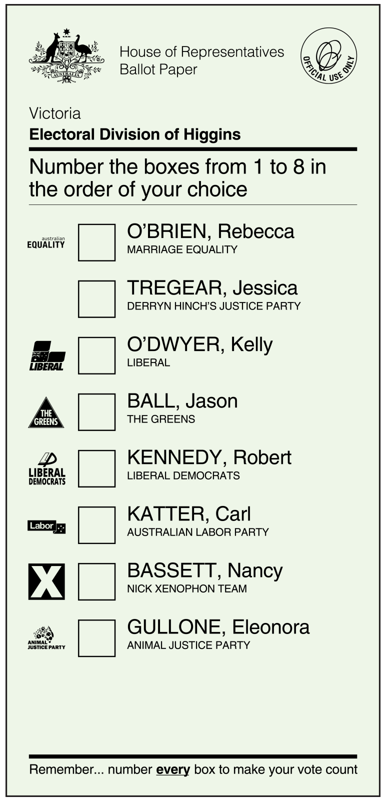
[16] In preferential voting systems, "donkey voting" is the act of preferencing candidates in the order they appear on ones ballot, irrespective of a voters true preference. This can be considered the *lazy* method of voting.

[17] This system is significantly more complex than the system in use in the House of Representatives. For detailed information on this system, see AEC (2022b).

[18] Unlike in the House of Representatives, incomplete ballots are not counted as invalid and are still used in a partial vote count.

[19] *Note*: Prior to the 2016 Australian federal election, the Senate used an alternate electoral system called "group ticket voting". Functionally, this meant that to vote "above-the-line", voters only had to list one "group", whilst to vote "below-the-line", voters had to list all candidates running in a state or territory. Post-2016, voting "above-the-line" became marginally more complex whilst voting "below-the-line" became significantly less complex. We control for this change by including election (year) fixed effects.

Figure 1: Example House of Representatives ballot paper



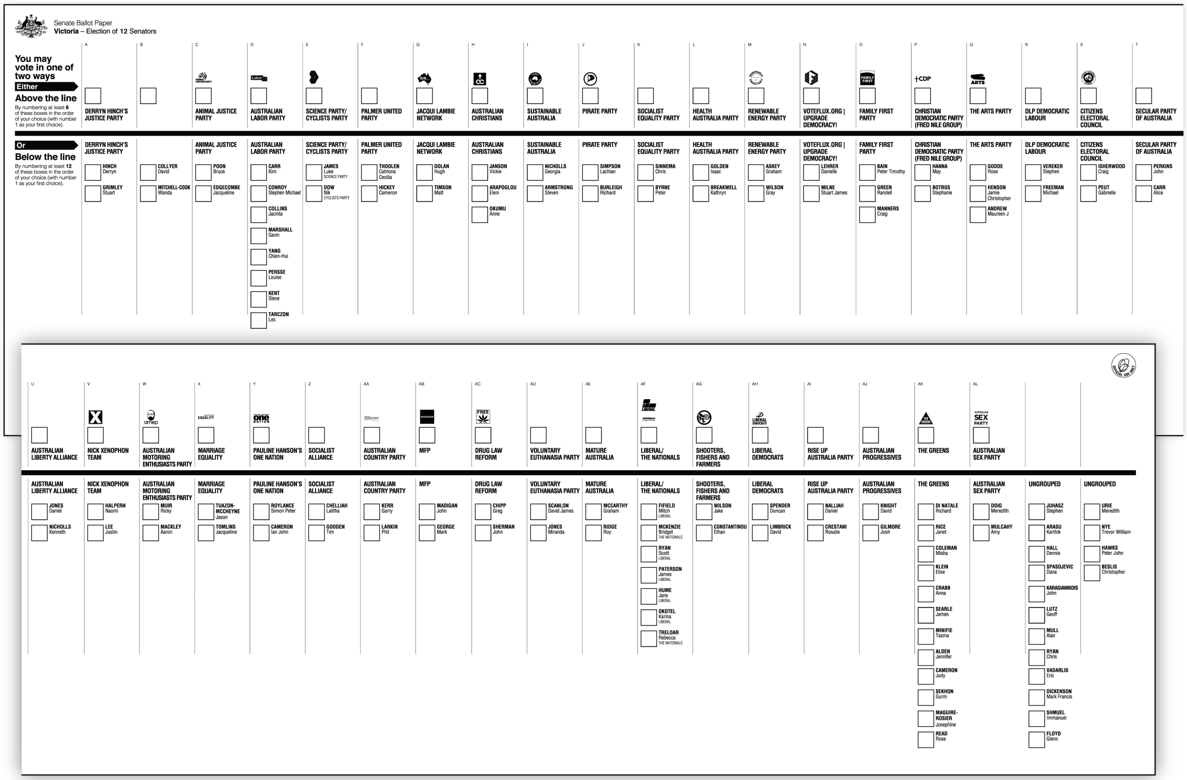
Source: (AEC 2022a).

senate faces four decisions. In order; whether to submit a legitimate vote, what method of voting to use, whether to "donkey vote", and how to allocate their preferences. These decisions are separate and are captured individually by the AEC.

On both ballots, voters are more likely to represent their true preferences on their ballots when compared to a "first-past-the-post" election[20]. In a "first-past-the-post" election voters can only list one preference. As a result, voters are disincentivised from voting for parties or candidates that are perceived to be unlikely to win an election (i.e., minor parties) as this can be seen to be "wasting" a vote. As such, these voting systems encourage

[20] This is the voting system used in the United States and the United Kingdom.

Figure 2: Example Senate ballot paper



Source: (AEC 2019b).

”strategic voting” and distort true preferences. In Australian elections, voters can list their true preferences over all potential candidates and have no incentive to strategically vote as it is not possible to ”waste” a vote.

III.b Mechanisms

From the literature, there are two primary mechanisms through which we would expect to see temperature impact voting outcomes in an Australian federal election; changes in cognition and issue salience.

Firstly, we expect to see heat produce additional stresses on the brain both on election days and on hot nights before an election (Carias et al. 2022). As a result, we expect to see a shift from system 2 thinking to system 1 thinking and observe an increased reliance on heuristics in behaviour of voters (Heyes & Saberian 2019). As such, heat on election days may induce undecided voters to switch their votes to parties which; i) are more salient on election days[21], ii) undecided voters have previously voted for, and/or, iii) undecided voters observe those around them voting for. The direction of this mechanism is likely to change depending on the voting history (the latent heuristics) of a polling place.

Secondly, previous research has demonstrated that elevated temperatures increase the issue salience of environmental issues (Guber 2001; Egan & Mullin 2012; Herrnstadt & Muehlegger 2014; Bromley-Trujillo et al. 2019). If hotter temperatures cause voters to have an increased awareness of environmental issues as they vote, their preferences over parties may shift towards parties which are perceived to be more "pro-environment" in their policies.

IV Data

In order to examine the link between temperature and voting outcomes at the ballot box, a novel panel dataset was created, which links detailed climate data to data on Australia federal elections and demographic characteristics.

[21] Polling places on election days are frequently staffed by partisan volunteers handing out "how-to-vote" cards. We expect larger parties have more volunteers and more advertising at polling places, thus, this mechanism may induce a swing away from independent parties and towards larger parties.

IV.a Climate

Climate data were sourced from the National Centre for Environmental Information's (NCEI) Global Surface Summary of the Day (GSOD) database (NCEI 2023). Data were collected at daily intervals on maximum temperature, minimum temperature[22], and precipitation[23] between January 1st, 2001 and June 30th, 2022. Between this period 762 weather stations were reporting across mainland Australia, Tasmania, and Australia's coastal waters.[24] Figure 3 maps the reporting weather stations and demonstrates that there is a broad coverage across Australia in the reporting weather stations, with dense coverage in cities which extends far into more remote areas of the Australian interior. This allows for the interpolation of climatic data to maintain a high resolution between both urban and rural areas.

To interpolate observations on climatic data from weather stations across Australia, we implemented residual inverse distance weighting (RIDW). This class of interpolation has been demonstrated to minimise errors in interpolation (Ninyerola et al. 2007; Wu & Li 2013) when combined with data on elevation (Stahl et al. 2006) and distance to the coastline (Salet 2009), specifically when estimating temperature (Nalder & Wein 1998), including in the Australian context directly (Ireland et al. 2023)[25]. Following established methodology,

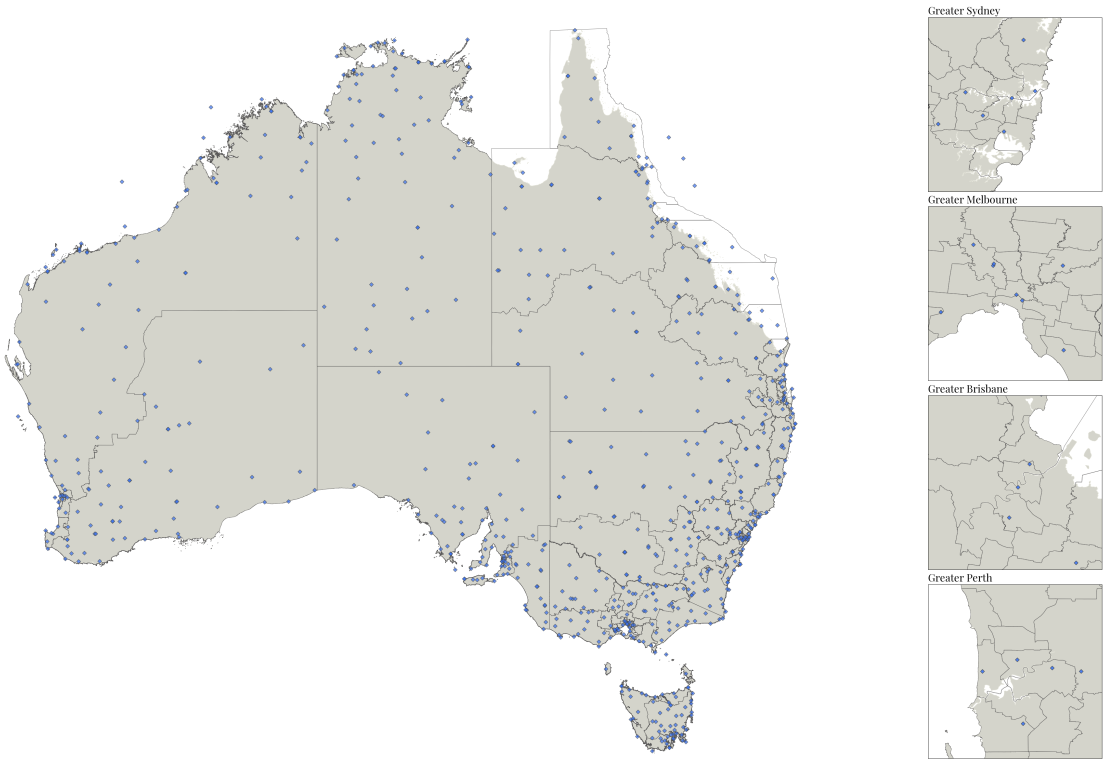
[22] 1,101 observations (or 0.03% of the sample) were missing entries for either maximum or minimum daytime temperature. These entries were dropped.

[23] 17,680 observations (or 0.46% of the sample) were missing entries for precipitation. Following NCEI guidelines, the precipitation values for these observations were assumed to be 0mm.

[24] The majority of these weather stations were not reporting for the entire collection period. Weather stations were included in data collection if they reported for at least one day during the collection period. The average weather station reported data for 5008 days or 61% of the collection period. As a result, there may be some variability in the quality of the interpolation of climatic data between days analysed.

[25] Specifically, RIDW interpolation has been demonstrated to minimise root mean square errors from interpolation when compared to other common interpolation methods, including OLD and IDW.

Figure 3: Reporting Weather Stations



Note: Each dot represents a weather station which reported for at least one day between 01/01/2001 - 30/06/2022. Not all of the weather stations mapped above report simultaneously in the data. Internal borders are electoral divisions from the 2022 Australian federal election.

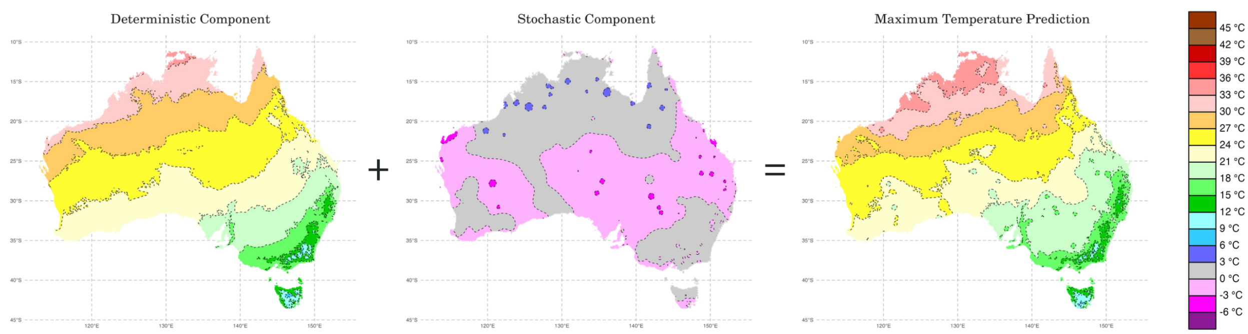
we firstly generate a grid of points over Australia at a 0.1° latitude-longitude resolution, generating 69,549 individual points across Australia. Then, using latitude, longitude, elevation[26], and distance to the coastline[27] as regressors, estimates of climatic variables are generated from the pre-existing weather observations using an Ordinary Least Squares (OLS) regression for each individual grid point. This generates a point's "*deterministic*" component - the component of a climatic variable on a given day that is determined by a point's physical characteristics. Then, the residuals from the OLS prediction are

[26] Elevation data sourced from AWS (2024).

[27] Data sourced from ABS (2023).

themselves interpolated across the grid of points using inverse distance weighting (IDW)[28], generating a point's "*stochastic*" component - the component of a climatic variable on a given day that cannot be accounted for by a point's physical characteristics; random noise in the allocation of the variable. A point's final observation is the sum of it's "deterministic" and "stochastic" components[29]. Figure 4 displays an example of the RIDW interpolation method using temperature data from the 2022 federal election.

Figure 4: RIDW interpolation for the 2022 Federal Election - 21/05/2022



Additionally, monthly average temperatures for each point were generated by taking the average temperature values recorded at each weather station in each month and interpolating these values using RIDW. These average temperatures were used to generate relative temperatures - the difference between a climatic variables absolute temperature and the temperature we expect based on the monthly average. Appendix A contains detailed maps of monthly average maximum and minimum temperatures recorded across Australia between 2001 - 2022.

[28] For a detailed explanation of IDW, refer to Childs (2004).

[29] Due RIDW relying on OLS prediction for the "*deterministic*" component, interpolated values are not bounded by 0. As such, some entries of precipitation are negative. The magnitude of this effect is minor and is unlikely to impact estimation.

Australia has a highly varied climate with hot, arid deserts in the centre of the continent, cold, mountainous ranges in the south-east, and tropical, monsoonal conditions in the far north. This provides a high amount of variation in maximum daytime temperatures across both the time and spatial dimensions of the panel. The average temperature recorded at polling places during Australian elections was 20°C whilst the average minimum temperature recorded on the day before Australian elections was 9°C[30]. Appendix B contains detailed absolute temperature maps across Australia for each election day and night in the sample, whilst Appendix C contains detailed relative temperature maps for the same selection.

IV.b Elections

Data on Australian federal elections was sourced from the Australian Electoral Commission's (AEC) "Tally Room" database (AEC 2023b). Data were collected at the polling place level for the past seven federal elections[31] for both the House of Representatives and the Senate. Only polling places which were active for all seven federal elections formed the sample[32]. Crucially, as we are using polling places as the individual units of observation, we drop "pre-poll" polling stations - the amalgamation of all forms of non-election-day voting (i.e., postal voting, overseas voting, telephone voting, early voting, etc.), as these polling stations have their location set at the divisional level - a geographic region - rather than

[30] Minimum daily temperatures the day before an election are used as a proxy for temperatures recorded on the night-before an election, following Carias et al. (2022).

[31] In order: 2004, 2007, 2010, 2013, 2016, 2019, & 2022.

[32] Additionally, 111 polling places (or 1.3% of the dataset) are mobile polling places; these primarily service remote communities, individuals in nursing homes, and individuals in prisons. As these polling places are not fixed we cannot assign a specific temperature value to them and they are dropped from the sample. For more information on mobile polling places, refer to AEC (2024b).

an individual location[33]. We address for potential self-selection related to pre-poll and early voting as a robustness check in Section V. The final sample contains 5,422 individual polling places across 7 elections.

Figure 5 displays a map of all Australian polling places active across all of the past seven federal elections. Key variables collected include; geographic locations of each polling place, total ballots issued in each polling place, first-preferences for each party in each polling place, voter turnout in each division, preference flows between parties in each polling place, informal votes in each polling place[34], and the number of votes cast using each method of Senate voting. Climatic data from each election is then linked to each individual polling place in each election year forming the base unit of the panel.

On average, there were 1,342 votes issued in each polling place with the largest polling place recording 7,101 votes and the smallest recording only 2 votes. The average level of turnout in each polling place was 92.8% with a standard deviation of 2.6%. Appendix D displays frequency distributions for total votes and turnout across the sample.

IV.c Demographics

Demographic controls were sourced from the Australian Bureau of Statistics' (ABS) "Census Datapacks" database (ABS 2024) on the last four Australian censuses[35]. Data were

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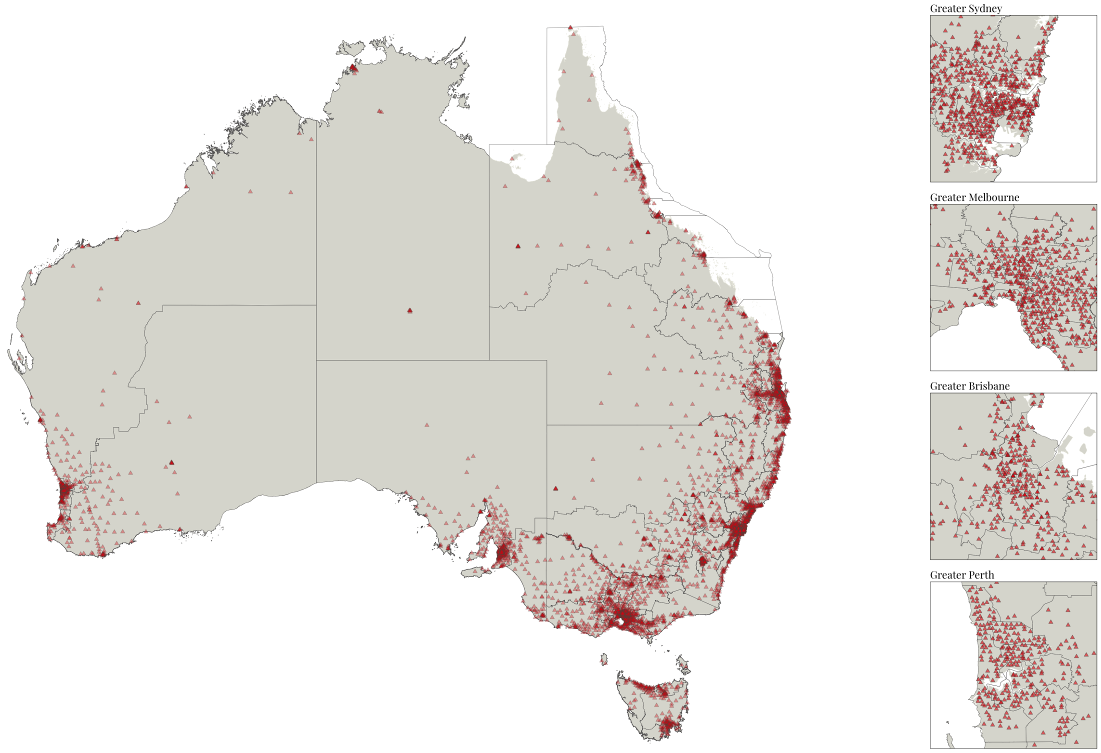
33 In the 2022 election, polling places of this type made up 16% of the total.

34 Data on informal votes are only collected by the AEC in the House of Representatives. Data on informal voting in the Senate is not collected.

35 In order: 2006, 2011, 2016, 2021

Figure 5: Polling Places



Note: Each dot represents a polling place which reported for each Australian federal election between 2004 and 2022. Mobile polling places are not included in the final sample. Internal borders are electoral divisions from the 2022 Australian federal election.

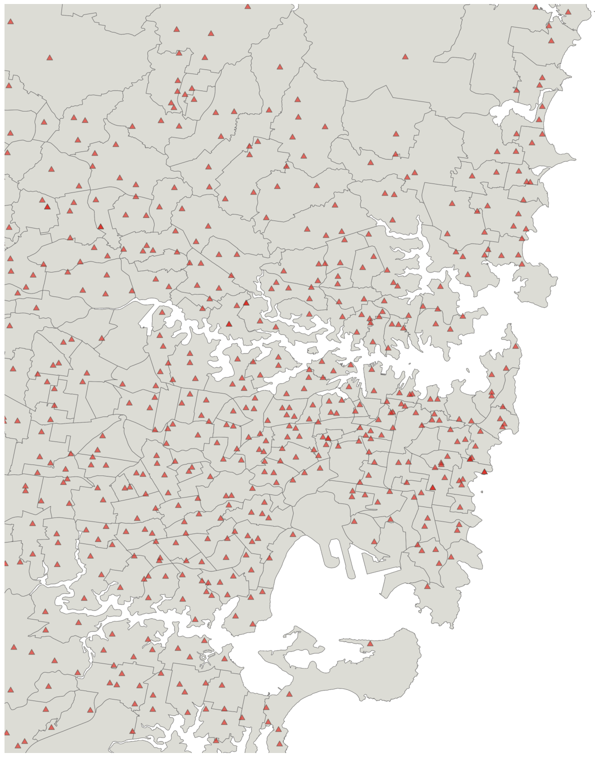
collected at Statistical Area 2 (SA2) level geographies[36] (ABS 2023; G. Australia 2023) which was then linked to individual polling places in each year[37]. Figure 6 displays SA2 level geographies in the Greater Sydney region with polling places overlaid for context. Following Gomez et al. (2007), demographic controls include median age, median family weekly income[38], percentage female, percentage completed tertiary education, and percentage of

[36] Specifically, 2021 SA2 level geographies. This unit of geography changes between censuses and was normalised between censuses during data cleaning.

[37] Due to election years and census years not sharing the same frequency, there is some level of duplication of demographic controls within the time-level of the panel. Additionally, there are often multiple polling places within a single SA2 geography leading to a duplication of demographic controls within the individual-level of the panel.

[38] Denoted in 2021 Australian Dollars (AUD).

Figure 6: SA2 level geographies in the Greater Sydney region



Note: Data on SA2 geographies is sourced from G. Australia (2023). The boundaries displayed are for the SA2 level geographies used in the 2021 census. This unit of geography changes between censuses and was normalised during data cleaning.

individuals whom only speak English at home[39]. See Appendix E for descriptive statistics of demographic controls at the polling place level.

IV.d Party Funding

Data on political party-level funding was sourced from the AEC's "Transparency Register" (AEC 2024a). The funding a political party receives in each election is calculated as the total receipts filed in the financial years between elections[40]. Funding was aggregated

[39] This is used as a proxy for the ethnic composition of an electorate.

[40] Receipt filing is governed by the AEC under the Commonwealth Electoral Act (1918) (C. o. Australia 1918; AEC 2023c).

at the party-group level[41]. Appendix F contains detailed information on political party funding in each election.

V Methodology

V.a Primary Specification

We employ a two-way fixed-effects regression model to estimate the causal effect of temperature on voting outcomes. Equation (1) displays the baseline model:

$$\begin{aligned} Votes_{i,t,p} = \beta_0 + \beta_1 Temp_{i,t} + \beta_2 NightTemp_{i,t} + \beta_3 \overline{Temp_{i,t}} + \beta_4 \overline{NightTemp_{i,t}} \\ + \gamma \mathbf{X}'_{i,t} + \alpha_i + \alpha_t + \epsilon_{i,t,p} \qquad \forall\, p \in P \end{aligned} \tag{1}$$

where $Votes_{i,t,p}$ is the estimated proportion of first-preferences[42] a political party p receives at a polling place i on an election day t. This dependent variable is modified to accommodate other types of voting and non-voting decisions, including; informal voting[43], type of voting[44], "donkey voting"[45], and the distribution of final preferences[46]. $Temp_{i,t}$ is the absolute temperature recorded at a polling place on an election day, $NightTemp_{i,t}$ is

[41] I.e., if funds were separately registered by different state-level party branches, these were added together for a national sum.

[42] Where a "1" is placed next to a party on a ballot paper.

[43] Where a ballot is submitted incorrectly, invalidating the vote.

[44] The type of vote an individual lodges in the Senate.

[45] Where a voter places preferences in the order that options appear on their ballot paper.

[46] How votes are allocated between the final two remaining candidates in a division ("run-off") after all down-ballot preferences have been allocated.

the absolute temperature recorded at a polling place on the night before an election[47], $\overline{Temp_{i,t}}$ is the daytime relative temperature[48] recorded at a polling place on an election day, and $\overline{NightTemp_{i,t}}$ is the overnight relative temperature recorded at a polling place on the night before an election. Our coefficients of interest are the aggregate of β_1, β_2, β_3, & β_4 - the net effect of absolute and relative daytime and overnight temperatures on voting.

Additionally, the vector $\mathbf{X}'_{i,t}$ denotes a set of individual and time variant controls. These include age, education, income, language spoken at home, and gender[49], as well as precipitation[50]. α_i are polling-place fixed effects, α_t are election-year fixed effects, and $\epsilon_{i,t,p}$ is the error term[51]. Finally, our preferred specification of equation (1) includes quadratic terms for $Temp_{i,t}$, $NightTemp_{i,t}$, $\overline{Temp_{i,t}}$, and $\overline{NightTemp_{i,t}}$. We display non-linear estimates of equation (1) for a number of specifications of $Votes_{i,t,p}$ in Section VI.

Equation (2) displays a secondary model in which pool all parties together simultaneously:

$$\begin{aligned} Votes_{i,t,p} = \beta_0 + \beta_1 Temp_{i,t} + \beta_2 NightTemp_{i,t} + \beta_3 \overline{Temp_{i,t}} + \beta_4 \overline{NightTemp_{i,t}} \\ + \gamma \mathbf{X}'_{i,t} + \gamma Funding_{t,p} + \alpha_i + \alpha_t + \alpha_p + \epsilon_{i,t,p} \end{aligned} \quad (2)$$

47 This is following Carias et al. (2022) which demonstrates that temperatures the night before a decision is to be made has a significant impact on decision-making. We utilise the minimum daily temperature recorded the day before an election to proxy for overnight temperature.

48 Defined as the difference between the maximum temperature recorded and the expected maximum temperature at a polling place on an election day, which is in turn based on the monthly daytime maximum average temperature. See Appendix A and Appendix C for more information on relative temperatures.

49 This follows the controls used in Gomez et al. (2007).

50 Bassi (2019) shows that precipitation impacts voting outcomes at the ballot box.

51 Standard errors are heteroskedasticity-robust and clustered by polling place, the individual unit in our panel (Abadie et al. 2023). This accounts for the non-independence of observations at the polling place level over time: characteristics specific to that polling place that may affect the vote - rural vs. agricultural, focused campaigning, status of the division as a swing seat, etc.

which includes two new terms. $Funding_{t,p}$ is a time-variant, party-related variables which controls for political party funding. This is included to proxy for the "campaign intensity" effect identified in Fraga & Hersh (2011). This vector may be modified to include other party-variant controls which may interact with both voting outcomes and temperature - notably, an "environmental stance" variable (see Section VII for further information). α_p are party-level fixed effects[52]. This secondary specification is used to test for any party-variant effects on voting outcomes which might interact with temperature.

V.b Pre-Poll Assumption

In Australian federal elections, voters may cast early ballots up to two-weeks prior to election day. We assume that pre-poll and election-day voters are *not* systematically impacted by temperature differently. This assumption may be violated if the population of pre-poll voters is older than election-day voters, as the effects of temperature on cognition increase in age (Khan et al. 2021; Lo et al. 2021; Hou & Xu 2023). To test this assumption, we include an alternate specification of temperature; $2WkTemp_{i,t}$ & $\overline{2WkTemp_{i,t}}$. This specification of temperature is a weighted average of daily maximum (and minimum) temperatures recorded in the two-weeks preceding (and including) an election. Temperatures are weighted according to an increasing exponential function, with increasing weight placed on dates closer to an election, representing the increasing number of ballots cast as election days approach. Appendix E contains descriptive statistics of these "two-week" temperature variables.

[52] As the sum of votes in a polling place is always equal to 1, the coefficients on all party-invariant variables are thus definitionally equal to 0.

VI Results

The following results are sorted into two types of decisions; non-voting and voting decisions. Non-voting decisions are decisions that occur in the process of voting but are unrelated to voting outcomes directly; whether to turnout, whether to informally vote, what method of voting to use, etc. Voting decisions are the decisions taken whilst voting which directly impact voting outcomes; which parties to vote for and in what order to list preferences.

VI.a Non-Voting Decisions

Non-voting decisions do not involve political parties. As such, the following decisions isolate changes in cognition as the only potential mechanism through which temperature can influence decision-making. As such, these decisions are of particular importance in assessing the cognitive impacts of temperature on decision-making in isolation of other potential mechanisms.

VI.a.1 Turnout

Estimates of equation (1) for voter turnout are reported in Table 1. In the first column, linear estimates of turnout as a function of temperature are reported. The sign of both absolute and relative temperatures in daytime and overnight temperatures are inconsistent, but estimates for all variables are highly statistically significant. Column two includes quadratic terms for all temperature variables, presenting non-linear results which are consistent with the estimates found in column one. These results imply that a 1 standard deviation increase in daytime maximum temperatures on election day (5.1°C) results in

Table 1: % Turnout (Normalized)

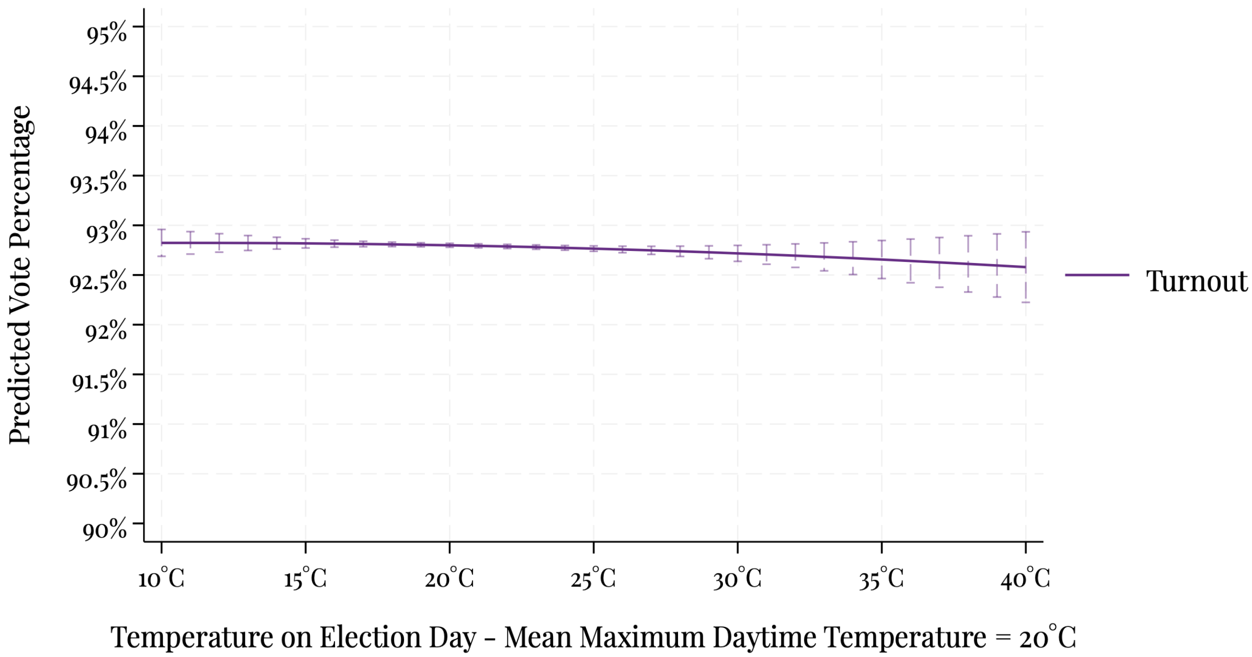
	(1) Linear	(2) Non Linear
Day Max Temperature (°C)	-0.00430***	-0.00570***
	(0.00048)	(0.00060)
Night Min Temperature (°C)	-0.00168***	-0.00161***
	(0.00039)	(0.00040)
Day Max Temp. Anomaly (°C)	0.00246***	0.0030***
	(0.00026)	(0.00032)
Night Min Temp. Anomaly (°C)	-0.00151***	-0.00152***
	(0.00020)	(0.00022)
Day Max Temperature² (°C)		0.00075***
		(0.00012)
Night Min Temperature² (°C)		-0.00078***
		(0.00013)
Day Max Temp. Anomaly² (°C)		-0.00023***
		(0.00005)
Night Min Temp. Anomaly² (°C)		0.00001
		(0.00005)
Controls	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes
Election-Year Fixed Effects	Yes	Yes
Observations	36456	36456

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Table reports two-way fixed-effects estimates. The unit of observation are individual polling places recorded in each election year. Standard errors are reported in parenthesis and are cluster-robust within polling places. "Anomaly" variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

a fall in turnout by 0.57%. By itself, this result appears to be an economically significant relationship. However, as relative temperatures depend on absolute temperatures it is hard to ascertain the economic significance of the above results. As such, tabulated results throughout this paper will be paired with graphs that display how an increase in

Figure 7: % Turnout - Daytime Temperatures



Note: Graphs are based on the average Australian polling place. Mean maximum daytime temperatures are equal to 20°C on election days between 2004 - 2022. Deviations from the mean are plotted on the graph. Bars display 95% confidence intervals.

temperature impacts voting outcomes at the average polling place[53].

Figure 7 displays the impact of election-day daytime maximum temperatures on the level of turnout on an election day. A two standard deviation increase in daytime maximum election-day temperature (approximately 10.3°C) is associated with a 0.1% fall in election-day turnout. This is an economically insignificant result. Additionally, as we move away from plausible temperature deviations[54] we witness confidence intervals increasing - pointing towards increasing uncertainty and implausibility of temperature readings this

[53] Graphs throughout this paper represent the average polling place's response to temperature. This means that all else held equal, at the average polling place, we expect the plotted vote-share to occur at a given temperature.
Averages for temperature and control variables are reported in Appendix E.

[54] 99% of daytime temperature anomalies in our sample are between -6°C and +9°C. See Appendix G for detailed absolute and relative temperature descriptive statistics.

high occurring at the average polling place. When examining a similar graph for overnight temperatures, we see a stronger (but still weak) relationship between temperature and turnout in Australian federal elections. However, it is worth noting that the range of plausible temperatures for overnight minimum temperatures is smaller than for daytime minimum temperatures[55]. A 1 standard deviation increase in overnight temperatures (4.7°C) results in a 0.35% fall in turnout. Whilst statistically significant, at the average polling place this only corresponds to a fall in 5 votes[56] - not economically significant[57].

This result confirms the primary assumption; temperature does not appear to have a meaningful impact on rates of turnout in Australian federal elections. As such, we do not expect to see self-selection in our sample for decisions made at the intensive margin of voting and we expect that further results capture the extensive margin voting decisions in isolation.

VI.a.2 Informal Voting

Informal voting is where a voter incorrectly submits their ballot, invalidating their vote. As informal voting is the less cognitively demanding decision, we expect to see informal voting increase in temperatures. Table 2 reports results for informal voting in the House of Representatives[58]. Column one displays linear estimates for the impact of temperature on informal voting whilst column two presents non-linear estimates. Once again, we

[55] 99% of overnight temperature anomalies in our sample are between -7°C and +6°C.

[56] The average polling place between 2004 and 2022 recorded 1342 votes.

[57] A corresponding graph for overnight temperatures is reported in Appendix H.

[58] Data on informal voting in the Senate is not collected by the AEC due to complexities in what is considered to be an informal vote in Senate voting.

Table 2: % Informal Votes (Normalized)

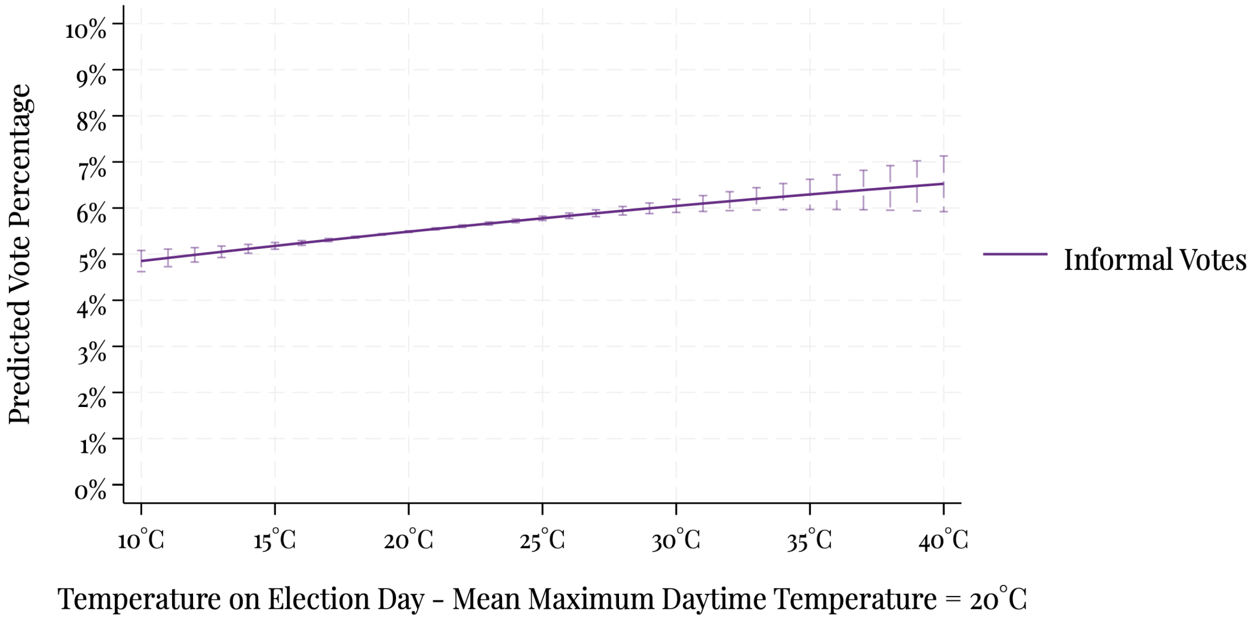
	(1) Linear	(2) Non Linear
Day Max Temperature (°C)	-0.003100***	-0.00461***
	(0.00060)	(0.00072)
Night Min Temperature (°C)	-0.00212***	-0.00268***
	(0.00051)	(0.00057)
Day Max Temp. Anomaly (°C)	0.00351***	0.00410***
	(0.00036)	(0.00042)
Night Min Temp. Anomaly (°C)	0.00136***	0.00162***
	(0.00028)	(0.00031)
Day Max Temperature² (°C)		0.00085***
		(0.00010)
Night Min Temperature² (°C)		-0.00069***
		(0.00013)
Day Max Temp. Anomaly² (°C)		-0.00023***
		(0.00007)
Night Min Temp. Anomaly² (°C)		0.00034***
		(0.00008)
Controls	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes
Election-Year Fixed Effects	Yes	Yes
Observations	37919	37919

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Table reports two-way fixed-effects estimates. The unit of observation are individual polling places recorded in each election year. Standard errors are reported in parenthesis and are cluster-robust within polling places. "Anomaly" variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

see consistency between both specifications and statistical significance for all variables listed, though it is difficult to ascertain the overall impact of temperature on informal voting. Figure 8 displays the impact of election-day daytime maximum temperatures on informal voting. An increase in temperatures is associated with a near-linear increase in the incidence of informal voting at a polling place, with a 1 standard deviation increase in

Figure 8: % Informal Voting - Daytime Temperatures



Note: Graphs are based on the average Australian polling place. Mean maximum daytime temperatures are equal to 20°C on election days between 2004 - 2022. Deviations from the mean are plotted on the graph. Bars display 95% confidence intervals.

temperature being associated with a 0.5% increase in informal voting[59].

VI.a.3 House of Representatives - Ballot Position

In the House of Representatives, individuals are asked to list a number of preferences on their ballot. The order in which candidates appear on a voter's ballot is randomized[60] and as such, the position of a voter's first preference should be randomized. In practice, voters often perform what is known as a "donkey vote", where a voter places their preferences in perfect order down the ballot in the order in which candidates appear. This is in effect the "lazy" option. We capture only the first part of this process; the proportion of voters

[59] A corresponding graph for overnight temperatures is reported in Appendix H.

[60] For more information about the randomization process on ballot papers in Australian federal elections, see AEC (2019a).

Table 3: % First Preferences for 1st Option (Normalized)

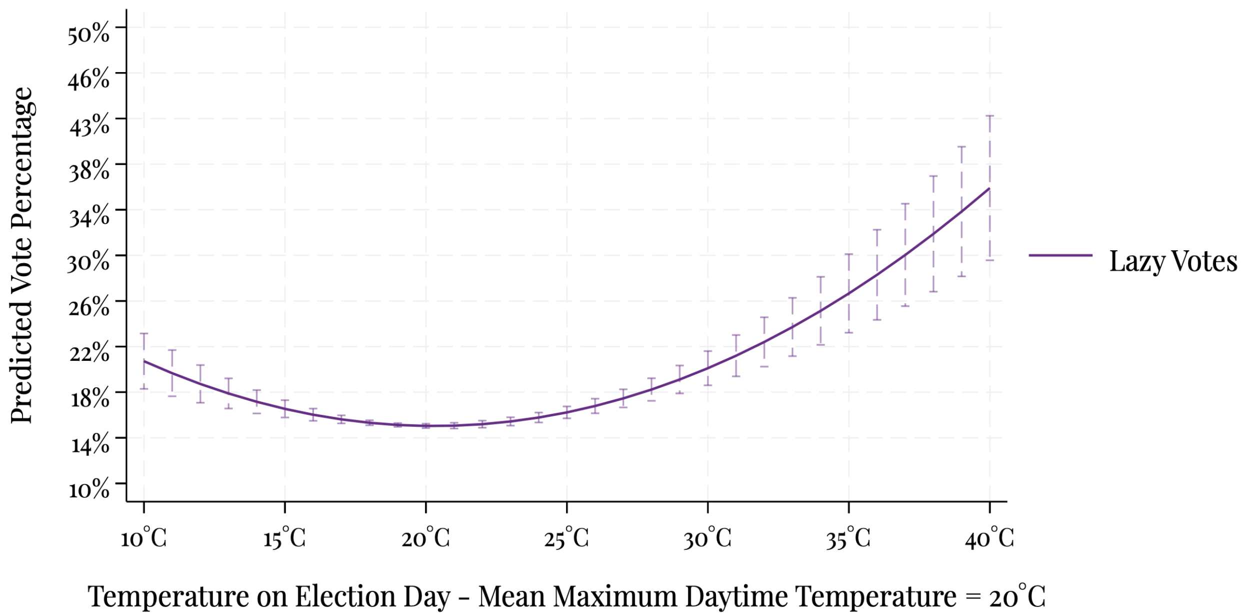
	(1) Linear	(2) Non Linear
Day Max Temperature (°C)	-0.04562***	-0.04407***
	(0.00711)	(0.00787)
Night Min Temperature (°C)	0.00096	0.00626
	(0.00572)	(0.00602)
Day Max Temp. Anomaly (°C)	0.02665***	0.02303***
	(0.00412)	(0.00452)
Night Min Temp. Anomaly (°C)	0.00193	-0.00147
	(0.00321)	(0.00335)
Day Max Temperature² (°C)		-0.00422***
		(0.00109)
Night Min Temperature² (°C)		0.00304***
		(0.00109)
Day Max Temp. Anomaly² (°C)		0.00524***
		(0.00080)
Night Min Temp. Anomaly² (°C)		-0.00265***
		(0.00081)
Controls	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes
Election-Year Fixed Effects	Yes	Yes
Observations	37919	37919

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Table reports two-way fixed-effects estimates. The unit of observation are individual polling places recorded in each election year. Standard errors are reported in parenthesis and are cluster-robust within polling places. ”Anomaly” variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

which place their first preference for the first candidate listed. Table 3 reports estimates for the proportion of voters ”lazy” voting in temperature. Column one displays linear estimates, whilst column two displays non-linear estimates. In this case, only election day daytime temperatures appear to have a statistically significant impact of ”lazy” voting. Figure 9 displays the impact of daytime temperature on ”lazy” voting for the average

Figure 9: % First Preferences for 1st Option - Daytime Temperatures



Note: Graphs are based on the average Australian polling place. Mean maximum daytime temperatures are equal to 20°C on election days between 2004 - 2022. Deviations from the mean are plotted on the graph. Bars display 95% confidence intervals.

polling place[61]. We observe that increased temperatures are strongly associated with an increase in the number of voter's first preference being the first option listed on their ballot paper - an indication that voters are becoming lazier in their decision making as temperature increases. A two standard deviation increase in the election-day daytime maximum temperature is associated with a 6% increase in voters reporting their first preference as the first candidate listed on their ballot. The magnitude of this effect appears to increase as temperatures become more extreme[62]. This result strongly supports the idea that temperature impacts decision-making through changes in cognition - because

[61] A corresponding graph for overnight temperatures is reported in Appendix H for transparency, though, as Table 3 reports, overnight temperatures do not appear to statistically significantly impact this decision.

[62] This results contradicts previous findings on the relationship between temperature and decision making. Heyes & Saberian (2019) find no evidence of non-linearities when assessing the relationship between temperature and decision-making context of judges parole and immigration decisions, whilst Carias et al. (2022) finds no evidence of non-linearities in the context of economic decision-making.

the position of political parties/individual candidates is randomized between electoral divisions there should be no relationship between political parties and the proportion of individuals listing the first option as their first preference. As such, these results are evidence that voters are becoming ”lazier” in their decision-making as the temperature increases.

VI.a.4 Senate - Below-the-Line Voting

In the Senate there are two different voting options; above-the-line or below-the-line. Voting below-the-line represents a significantly more complex set of decisions and as such we expect that, as temperature increases, incidences of below-the-line voting will decrease. Table 4 reports estimates for below-the-line voting. The linear and non-linear estimates display different magnitudes, but display consistent signs. Once again, we find evidence of non-linear impacts of temperature in decisions-making; as the temperature becomes more extreme the impacts of temperature on the decision of ”how to vote” increases in magnitude. Figure 10 displays the impact of election-day daytime maximum temperatures on incidences of below-the-line voting[63]. As temperatures increase we see a fall in voters choosing the more complex decision, though, within a plausible band of temperatures[64], this effect is limited - a two standard deviation increase in daytime maximum temperature on election-day is only associated with a 0.5% fall in voters choosing to vote below-the-line.

Broadly, this set of non-voting results corresponds to our initial hypothesis; elevated

[63] A corresponding graph for overnight temperatures is reported in Appendix H.

[64] See Appendix G for detailed descriptive statistics pertaining to absolute and relative temperatures in the sample.

Table 4: % Below-the-Line (Normalized)

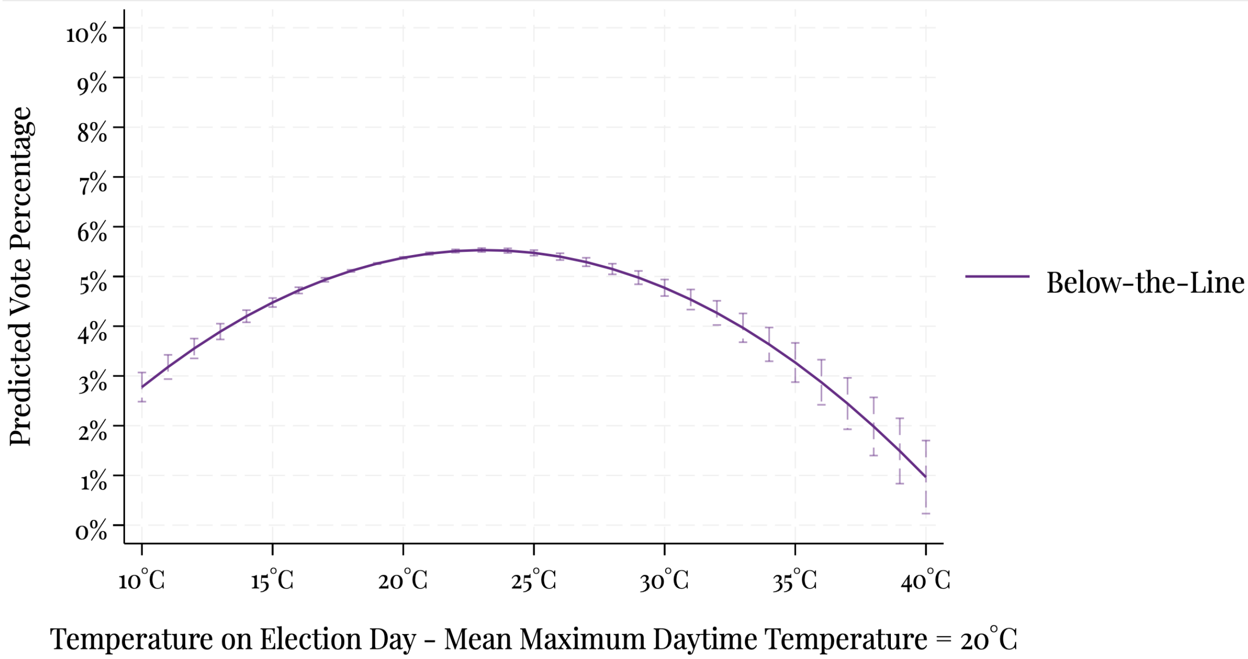
	(1) Linear	(2) Non Linear
Day Max Temperature (°C)	-0.00454***	-0.00112
	(0.00076)	(0.00096)
Night Min Temperature (°C)	0.00468***	0.00281***
	(0.00067)	(0.00075)
Day Max Temp. Anomaly (°C)	0.00410***	0.00314***
	(0.00043)	(0.00049)
Night Min Temp. Anomaly (°C)	-0.00280***	-0.00148***
	(0.00036)	(0.00039)
Day Max Temperature² (°C)		0.00106***
		(0.00012)
Night Min Temperature² (°C)		0.00023
		(0.00019)
Day Max Temp. Anomaly² (°C)		-0.00162***
		(0.00009)
Night Min Temp. Anomaly² (°C)		-0.00069***
		(0.00012)
Controls	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes
Election-Year Fixed Effects	Yes	Yes
Observations	37940	37940

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Table reports two-way fixed-effects estimates. The unit of observation are individual polling places recorded in each election year. Standard errors are reported in parenthesis and are cluster-robust within polling places. "Anomaly" variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

temperatures reduce cognitive capacity in complex decision-making. This is observed in increased incidences of informal voting, "lazy" voting, and reduced incidences of below-the-line voting in elevated temperatures.

Figure 10: % Below-the-Line - Daytime Temperatures



Note: Graphs are based on the average Australian polling place. Mean maximum daytime temperatures are equal to 20°C on election days between 2004 - 2022. Deviations from the mean are plotted on the graph. Bars display 95% confidence intervals.

VI.b Voting Decisions

We now examine the impact of temperature on voting decisions - decisions which directly impact voting outcomes. In these decisions, the influence of political parties is present and it is not possible to disentangle the two primary mechanisms through which we expect temperature to impact voting outcomes; changes in cognition and issue salience. We propose methods of separating these two mechanisms in Section VII.

VI.b.1 House of Representatives

Estimates for first preferences by political party are reported in Table 5 according to our preferred non-linear specification[65]. Column one reports coefficients for the Liberal/National Coalition (LNP), column two reports coefficients for the Australian Labor Party (ALP), column three reports coefficients for the Australian Greens (GRN), column four reports coefficients for an aggregate of all other independent parties and candidates (IND), and column five reports coefficients for informal voting (INF), as in Table 2. Aside from the general statistical significance of temperature in determining first-preference vote shares for all parties, the direction of the effects between parties is difficult to discern. Figure 11 plots daytime temperature coefficients for the average polling place. Whilst the two major political parties (LNP & ALP) do not appear particularly sensitive to increased temperatures (a two standard deviation increase in election-day daytime maximum temperatures (10.3°C) results in a 1% increase in first preferences for the LNP, and a 0.1% decrease in first preferences for the ALP), election-day temperatures do appear to significantly impact smaller parties. The Australian Greens (an ostensibly pro-environment party) experiences a 1.7% increase in first preferences in a two standard deviation increase in daytime maximum temperatures, whilst independent parties experience a 3% decrease in first-preferences in the same increase in daytime maximum temperatures[66]. These results point to both changes in cognition and issue salience as active mechanisms in determining voting outcomes - see Section VII.

Estimates for the distribution of preferences in instant run-off elections between the two

[65] Linear estimates are reported in Appendix I.

[66] Appendix J presents corresponding graphs for election-night minimum temperatures.

Table 5: House of Representatives - Non-Linear (Normalized)

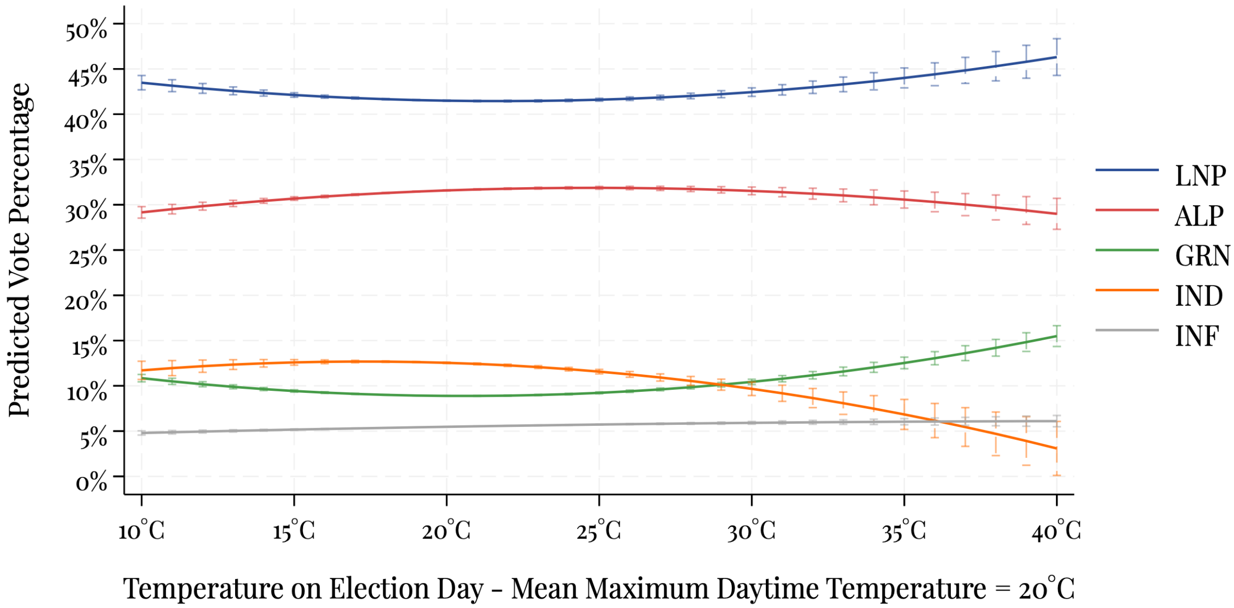
	(1) LNP	(2) ALP	(3) GRN	(4) IND	(5) INF
Day Max Temperature (°C)	0.00169	-0.00807***	0.00719***	0.00485	-0.00566***
	(0.00315)	(0.00239)	(0.00134)	(0.00404)	(0.00072)
Night Min Temperature (°C)	-0.03136***	0.01443***	0.01892***	0.00097	-0.00296***
	(0.00229)	(0.00182)	(0.00110)	(0.00276)	(0.00058)
Day Max Temp. Anomaly (°C)	-0.00215	0.00737***	-0.00438***	-0.00543**	0.00458***
	(0.00184)	(0.00141)	(0.00085)	(0.00243)	(0.00042)
Night Min Temp. Anomaly (°C)	0.01874***	-0.00658***	-0.00934***	-0.00458***	0.00176***
	(0.00127)	(0.00097)	(0.00065)	(0.00153)	(0.00031)
Day Max Temperature² (°C)	0.00113***	-0.00115***	-0.00208***	0.00121**	0.00090***
	(0.00040)	(0.00032)	(0.00018)	(0.00049)	(0.00010)
Night Min Temperature² (°C)	-0.00084*	0.00301***	0.00018	-0.00148***	-0.00086***
	(0.00049)	(0.00040)	(0.00017)	(0.00050)	(0.00013)
Day Max Temp. Anomaly² (°C)	0.00077***	-0.00060***	0.00190***	-0.00172***	-0.00035***
	(0.00026)	(0.00022)	(0.00014)	(0.00037)	(0.00007)
Night Min Temp. Anomaly² (°C)	0.00054*	-0.00031	-0.00013	-0.00049	0.00040***
	(0.00030)	(0.00026)	(0.00011)	(0.00040)	(0.00008)
Controls	Yes	Yes	Yes	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes	Yes	Yes	Yes
Election-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	36456	36456	36456	36456	36456

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Table reports two-way fixed-effects estimates. Estimates are for elections between 2004 - 2022. The unit of observation are individual polling places recorded in each election year for each political party. Standard errors are reported in parenthesis and are cluster-robust within polling places. "Anomaly" variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

major Australian political parties are presented in Appendix K. Both the signs and magnitudes of these effects are consistent between first-preferences and preference-flows, implying that the causal impact of temperature on voting outcomes exhibits consistency between voting sub-decisions (preference decisions for each individual party on a voter's ballot).

Figure 11: House of Representatives: First-Preferences - Daytime Temperatures



Note: Graphs are based on the average Australian polling place. Mean maximum daytime temperatures are equal to 20°C on election days between 2004 - 2022. Deviations from the mean are plotted on the graph. Bars display 95% confidence intervals.

VI.b.2 Senate

Estimates for first-preferences in the Senate are presented in Table 6 according to our preferred non-linear specification[67]. Columns one through four are of identical description as in the previous section. Whilst there is a general statistical significance of temperature in determining first-preferences in the senate, the linear estimates of daytime relative and absolute temperatures do not individually exhibit statistical significance - only the quadratic terms exhibit statistical significance. This indicates that daytime temperatures only impact party-wise senate voting outcomes in extreme maxima. Figure 12 plots daytime maximum temperatures on election day for the average polling place. Whilst these results appear to be distinct from the results found in the House of Representatives, when

[67] Linear estimates are reported in Appendix I.

Table 6: Senate - Non-Linear (Normalized)

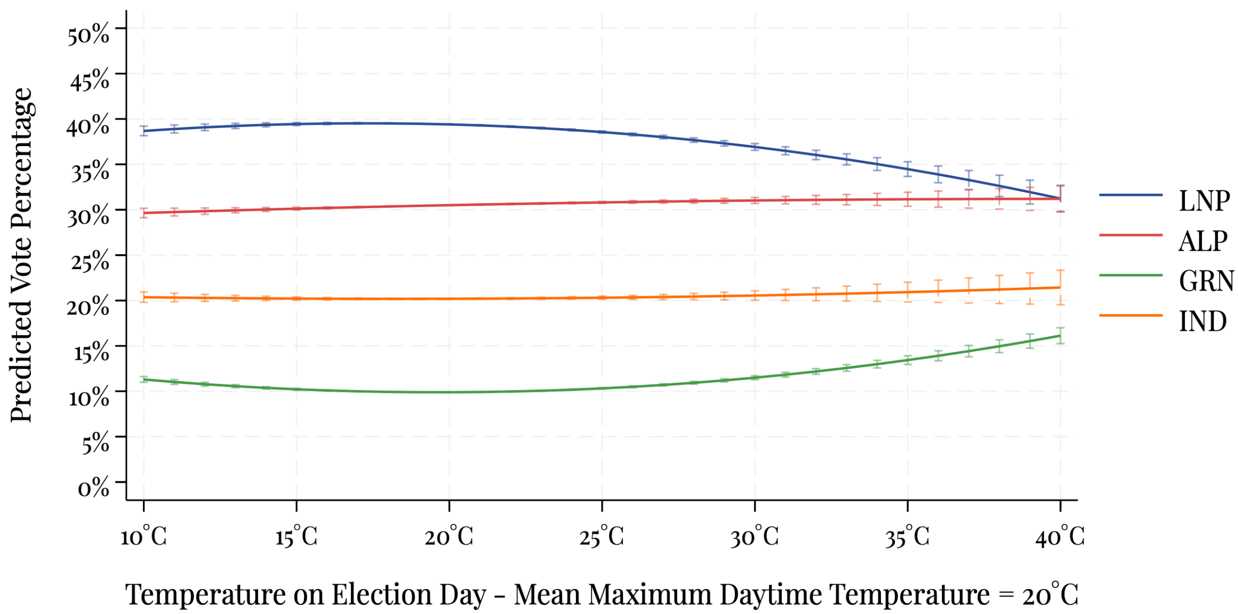
	(1) LNP	(2) ALP	(3) GRN	(4) IND
Day Max Temperature (°C)	-0.00222	0.00183	0.00157	-0.00118
	(0.00204)	(0.00190)	(0.00116)	(0.00246)
Night Min Temperature (°C)	-0.02937***	0.02678***	0.01981***	-0.01722***
	(0.00153)	(0.00147)	(0.00094)	(0.00182)
Day Max Temp. Anomaly (°C)	-0.00129	0.00088	-0.00055	0.00096
	(0.00119)	(0.00110)	(0.00072)	(0.00151)
Night Min Temp. Anomaly (°C)	0.01232***	-0.01553***	-0.00826***	0.01148***
	(0.00084)	(0.00082)	(0.00053)	(0.00101)
Day Max Temperature² (°C)	0.00156***	-0.00028	-0.00248***	0.00120***
	(0.00027)	(0.00026)	(0.00015)	(0.00030)
Night Min Temperature² (°C)	-0.00249***	0.00281***	-0.00127***	0.00096***
	(0.00036)	(0.00034)	(0.00017)	(0.00033)
Day Max Temp. Anomaly² (°C)	-0.00165***	-0.00005	0.00184***	-0.00014
	(0.00018)	(0.00018)	(0.00011)	(0.00022)
Night Min Temp. Anomaly² (°C)	0.00016	0.00058**	0.00014	-0.00088***
	(0.00020)	(0.00024)	(0.00010)	(0.00025)
Controls	Yes	Yes	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes	Yes	Yes
Election-Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	36456	36456	36456	36456

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Table reports two-way fixed-effects estimates. Estimates are for elections between 2004 - 2022. The unit of observation are individual polling places recorded in each election year for each political party. Standard errors are reported in parenthesis and are cluster-robust within polling places. "Anomaly" variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

we constrain the analysis to plausible temperatures, there appears to be a degree of consistency. We once again witness the Australian Greens increasing their first-preferences in temperature (a two standard deviation increase in temperature is associated with a 1.5% increase in first-preferences), as well as the ALP first-preference share remaining unaffected by elevated temperatures. However, we now observe a decline in the first-preference vote share of the LNP in the Senate (a sign change when compared to the House of Representatives) as well as independent parties/candidates experiencing no significant change in first-preference vote shares in the Senate (compared to the sharp decline experienced in the House of Representatives). We posit that these points of difference are driven by differences in the voting systems utilised by the House of Representatives and the Senate which result in significant differences in the number and type of independents present between the two chambers of government.

Figure 12: Senate: First-Preferences - Daytime Temperatures



Note: Graphs are based on the average Australian polling place. Mean maximum daytime temperatures are equal to 20°C on election days between 2004 - 2022. Deviations from the mean are plotted on the graph. Bars display 95% confidence intervals.

In the House of Representatives, candidates are elected from divisions which have an average population of 110,000 individuals. In the Senate, candidates are elected at the state-level, meaning there are fewer divisions and a greater population of electors proportional to each candidate. This results in the average number of independent candidates in the Senate (26) being far greater than in the House of Representatives (4). As such, independent parties and candidates *as an aggregate* may be less susceptible to falling vote-shares in elevated temperatures in the Senate simply because there are a greater number of niche independent parties which may appeal to an individual voter's underlying policy preferences when compared to their range of choices in the House of Representatives. When we interact this increase in the number of choices with elevated temperatures (and thus reduced cognition), it becomes simpler for a voter to pick a party based solely on a party whose name aligns with a strong preference they hold[68]. Put simply, the Senate contains more one-policy parties which appeal to less politically informed swing voters, which may in-turn increase the number of votes independents receive when voters are cognitively depleted. It is important to note, however, that our measure of independent candidates is an aggregate of all independent candidates and parties - the sensitivity of individual independent candidates' vote shares in elevated temperatures may be the same across both chambers of government[69].

However, our primary result remains the same between the House of Representatives and the Senate; voting outcomes at the ballot box appear to be statistically and economically significantly impacted by elevated temperatures. Additionally, as can be observed in the results in both the House of Representatives and the Senate, decreased temperatures do not appear to meaningfully alter voting outcomes, corroborating previous results which find that cold temperatures have limited-to-nil impacts on decision-making and cognition more broadly (Hancock & Vasmatzidis 2003; Baylis 2020; Liao & Junco 2022).

[68] Parties running for seats in the Senate in the 2022 federal election included; ”The Fishing Party”, ”Help End Marijuana Prohibition”, ”Australians Against Further Immigration”, ”Non-Custodial Parents Party”, and the ”No Goods and Services Tax Party”.

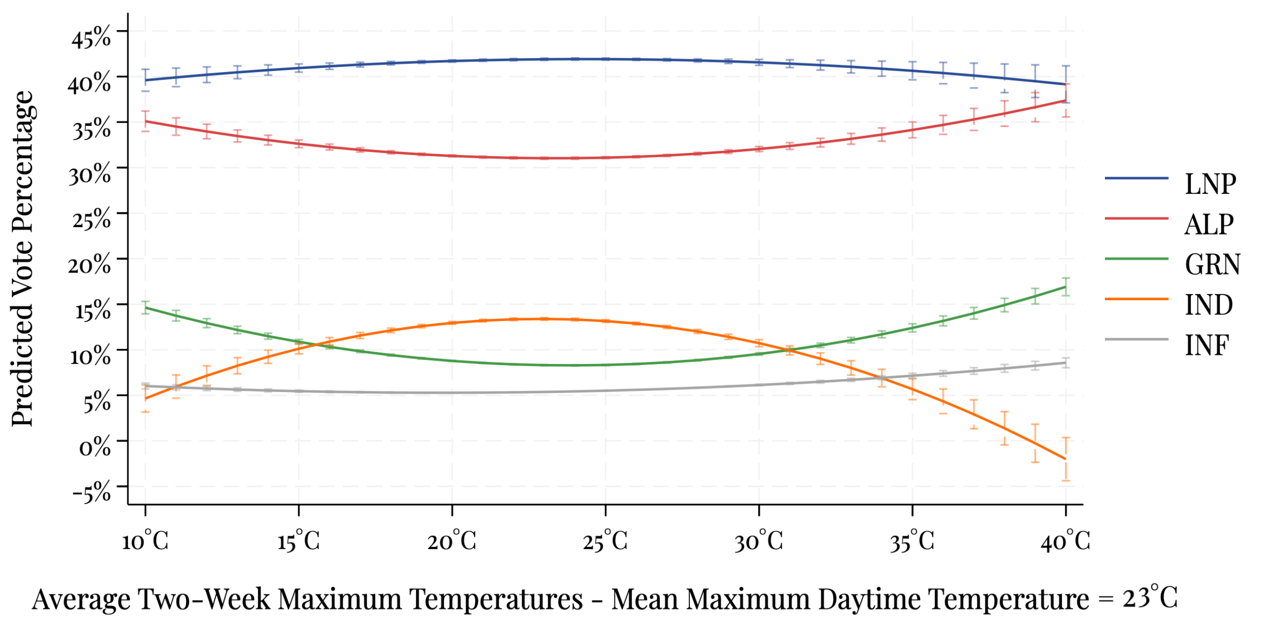
[69] As specific candidates and parties do not run in all elections in our sample, measuring the effect of temperature on individual independent parties and candidates would necessitate an alternate approach.

VI.c Robustness

VI.c.1 Two-Week Temperature Windows

We now move to employ our secondary specification of temperature - $2WkTemp_{i,t}$, a weighted average of temperatures over the two weeks leading up to and including election days - which aims to account for potential heterogeneity of the impacts of temperature on voting outcomes between pre-poll and election day voters. Figure 13 plots the results of this specification for the average polling place for each political party in the House of Representatives[70].

Figure 13: HoR: First-Preferences:
Two-Week Average Daytime Temperatures



Note: Graphs are based on the average Australian polling place. Mean maximum daytime temperatures over two-week windows are equal to 23°C on election days between 2004 - 2022. Deviations from the mean are plotted on the graph. Bars display 95% confidence intervals.

[70] Full results are reported in Appendix L.

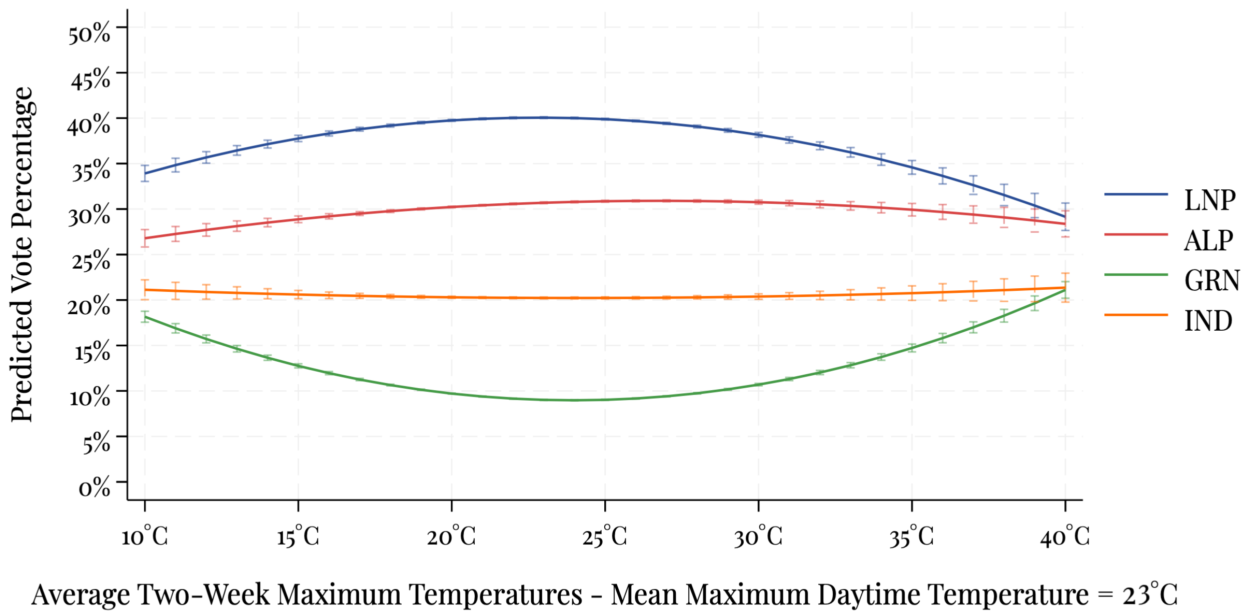
We see broad consistency in the results in the House of Representatives between the election day only specification of temperature and the two-week specification; informal voting increases in temperature, as does the share of votes received by the Australian Greens, and independent parties and candidates perform worse under elevated temperatures. We do, however, observe a sign change between the two major parties (LNP & ALP). We posit that this sign change may occur as the mechanism of issue salience may become dominant if temperatures are elevated over a longer period of time.

Generally speaking, the LNP is viewed as an anti-environment party by the Australian electorate whilst the ALP is viewed as relatively more pro-environment (Colvin & Jotzo 2021). If the dominant mechanism through which temperature-induced vote-switching occurs switches changes in cognition to issue salience as temperatures remain higher for longer, this may explain why we see a switch in sign between the two major parties when we extend the temperature window over a longer period of time. We present a method of testing this hypothesis in Section VII. It is important to note, however, that our primary finding - the presence of vote-switching in elevated temperatures - remains unchanged.

Figure 14 plots the results of the two-week temperature specification for the average polling place for each political party in the Senate[71]. Once again, we observe broad consistency in the results between the election day temperature and two week temperature specifications, with the sign of voting outcomes in temperature remaining consistent between both specifications. A notable point of difference lies in the non-linear effects of temperature on Senate voting outcomes, with the negative impacts of temperature

[71] Full results are reported in Appendix I.

Figure 14: Senate: First-Preferences:
Two-Week Average Daytime Temperatures



Note: Graphs are based on the average Australian polling place. Mean maximum daytime temperatures over two-week windows are equal to 23°C on election days between 2004 - 2022. Deviations from the mean are plotted on the graph. Bars display 95% confidence intervals.

becoming greater in more extreme temperatures for the Liberal-National Coalition, and the inverse becoming true for the Australian Greens. This reinforces our hypothesis that the mechanism of issue salience becomes dominant when temperatures are elevated over a longer period of time[72].

VI.c.2 Funding

To account for the "campaign intensity" effect described in Fraga & Hersh (2011), we separately analyse the impact that political party funding (a proxy for political party election spending) has upon voting outcomes in both the House of Representatives and

[72] Typically, the Australian Greens are viewed by the electorate as being strongly pro-environment whilst the Liberal-National Coalition are viewed as anti-environment (Colvin & Jotzo 2021; Cameron et al. 2022).

Table 7: Political Party Funding

	(1) HoR	(2) Senate
Funding ($ Millions AUD)	0.00132***	0.00108***
	(0.00000)	(0.00001)
Observations	182280	151760

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Table reports two-way fixed-effects estimates. Estimates are for elections between 2004 - 2022. The unit of observation are individual polling places recorded in each election year for each political party. Standard errors are reported in parenthesis and are cluster-robust within polling places.

the Senate. Estimates of equation (2) are given for political party funding in Table 7[73]. In both the House and the Senate, nation-wide political party funding has a statistically significant effect on the share of first-preferences a party receives at a polling place with an additional $1 million AUD being associated with a 0.13% increase in first preferences in the House of Representatives, and a 0.11% increase in first preferences in the Senate. These results are economically meaningful and potentially highlight localised political party election spending (i.e., funds on advertising spent in each electoral division) as a variable which may influence *what parties* are influenced by changes in cognition in elevated temperatures - for example, if voters rely more on heuristics under heat, we would expect that they may alter their vote towards political parties and candidates which have had a greater advertising presence in a voter's polling place. It should be noted that this result does not impact the primary finding of this research - temperature directly impacting voting decision-making through changes in cognition - but may potentially impact the party-level direction of this result. More research is needed to fully explore

[73] As we are simultaneously estimating the impact of the regressors on voting outcomes for all parties simultaneously, the estimates for any party-invariant regressors (like temperature or demographic controls) will be definitionally equal to 0. Hence, we do not report these coefficients.

the interaction between campaign spending and temperature-induced heuristic driven changes in voting outcomes.

VI.c.3 Sensitivity Tests

Figure 15 plots a suite of sensitivity tests for independent candidates in the House of Representatives[74]. Full panels of each robustness test in the House of Representatives and the Senate are reported in Appendix M[75].

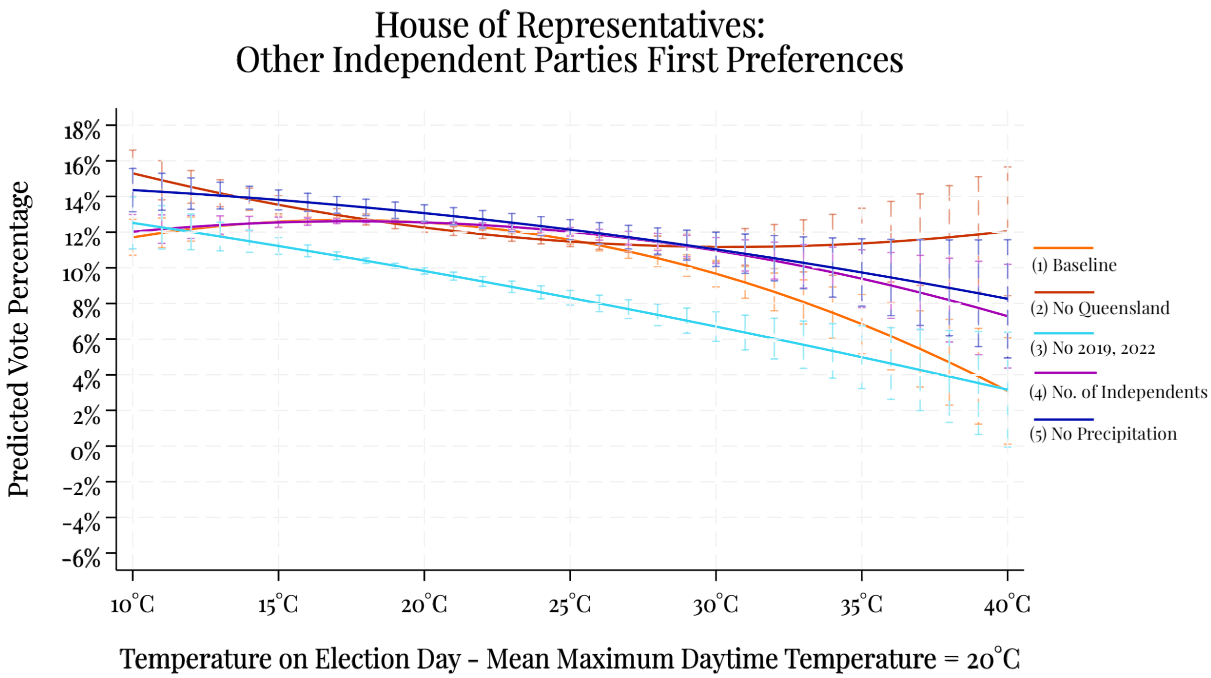
Queensland—

Queensland is Australia's northernmost state and has both a diverse set of micro-climates (BOM 2024) as well as a political culture which is unique from the rest of Australia (Perche et al. 2024). To rule out that our estimates are capturing idiosyncrasies which are unique to Queensland, we omit Queensland from our sample and re-estimate both our House of Representatives and Senate results. This excludes 34,685 observations out of a total 182,280 across our panel. Line two reports these results for independents in the House of Representatives at the average polling place. For independents, omitting Queensland from our panel provides linear estimates which are consistent with the baseline specification, but inverted signs for the quadratic terms. Whilst independents as an aggregate perform somewhat better when omitting Queensland, they are still worse-off when temperatures are elevated - a result largely consistent with the baseline specification.

[74] We present only this sliver of results for concise display.

[75] It is important to note that when looking at the results between sensitivity tests and the main specifications, we observe changes in magnitude and sign within the isolated estimates of temperature. However, the collective influence of temperature (absolute and relative temperatures including quadratic terms) remains consistent between specifications. This is why our preferred method of communicating these results is graphical rather than tabular.

Figure 15: House of Representatives - Daytime Temperatures; Sensitivity Tests



Note: Graphs are based on the average Australian polling place. Mean maximum daytime temperatures are equal to 20°C on election days between 2004 - 2022. Deviations from the mean are plotted on the graph. Bars display 95% confidence intervals.

Pre-Poll—

Early voting has become increasingly prevalent in Australian federal elections in the 21st century. In the 2004 federal election, 11% of ballots were cast as pre-poll votes. This has since increased to 41% in the 2019 federal election (P. o. Australia 2022). To account for heterogeneity in the proportion of pre-poll votes between years in our panel, we omit observations for the previous two elections (2019 and 2022) and re-estimate equation (1) in both the House of Representatives and the Senate. This excludes 52,080 observations out of a total 182,280. Line three reports these results for independents in the House of Representatives at the average polling place. Compared to baseline, we see consistency in the sign of both our linear and quadratic estimates with a lower overall level of votes for independent parties[76]. We see similar results for all parties examined.

Number of Independents—

One potential source of omitted variable bias comes from the number of independents registered in electorates. If (as is likely) the number of independent candidates in an electorate is correlated with population density, then the number of independent candidates may be correlated with both vote-shares for independents (impacting the vote-shares of all other parties as a result) and temperature (as reduced population density and increased average temperatures are correlated in Australia). To account for this potential source of bias, we include a new variable, $IndCount_{i,t}$ which counts the number of independent candidates present on the ballot at each polling place, in each election, and re-estimate our results. We find that the number of independent candidates on a ballot paper does significantly affect vote-shares for independents, with an additional independent party or candidate on a ballot paper being associated with a 1.2% increase in first-preferences for independents at a polling place in an election[77]. Line four reports these results for the House of Representatives at the average polling place, and we observe results consistent with our baseline estimation (with reduced magnitude in our quadratic terms).

Precipitation—

Precipitation is known to affect both mood (Denissen et al. 2008) and cognition (Bassi 2019). Whilst out preferred specification already includes a continuous measure of precipitation, we re-estimate our results after dropping all observations where precipitation is recorded

[76] A fact which may reflect increasing vote shares for minor political parties and independent candidates in the 2022 election.

[77] See Appendix M.

to discount the possibility of our results being driven by the influence of precipitation. This excludes 30,090 observations out of a total 182,280. Line five reports these results for independents in the House of Representatives at the average polling place, and we once again find estimates that resemble our baseline specification in both sign and magnitude.

VII Discussion

VII.a Conclusions

This research adds to a rapidly growing body of literature examining the link between elevated temperatures and decision-making. We contribute to this space by presenting findings which demonstrate that, under heat-stress, individuals perform worse when engaging in decisions which are procedural to the voting process - non-voting decisions. As non-voting decisions are decisions which are made without the influence of political parties, the effects of temperature on these decisions capture temperature's impact on cognition isolated from the mechanism of issue salience. In elevated temperatures, we witness an increase in informal voting, an increase in "lazy" or "donkey" voting, and a decrease in below-the-line voting (the more complex choice). These results all reinforce previous literature which finds that cognition is diminished in complex decision-making under heat stress.

We have also demonstrated that temperature directly influences voter's voting-decisions - the decisions which are influenced by political parties. Specifically, we present what we believe to be the first evidence, in a natural setting or otherwise, of vote-switching behaviour in elevated temperatures. Our central estimate is that a one standard deviation increase in temperature (5.1°C) at the average polling place results in 6.5% of swing voters altering their vote in the House of Representatives[78]. To contextualize this result, as of the most recent Australian federal election, eight seats in the House of Representatives are currently held by margins of 1% or less - meaning that a 1% swing in preference-flows to the opposition candidate in these seats would result in them changing representatives. Whilst our model cannot determine how down-ballot preferences change in response to elevated temperatures, the results do demonstrate that governments in parliamentary democracies are vulnerable to even mild random temperature shocks on election days.

These results also have broad implications for electoral politics in democracies with preferential voting systems. Firstly, parties which are generally viewed by the electorate to be pro-environmental appear to perform better under elevated temperatures. This strongly suggests that issue salience of environmental concerns under heat appears to be an active mechanism driving vote-switching behaviour.

Secondly, parties without a historic voter-base appear to perform worse in elevated temperatures, and increasingly worse in extreme temperatures. This suggests that vote-switching behaviour is also being driven by changes in cognition - under elevated temperatures, voters experience elevated cognitive stress which reduces deliberative, careful thought (System 2 thinking), and encourages impulse, rapid, heuristic-based decision-making (System 1 thinking). If voters are relying on heuristics to make voting decisions under heat, then we would expect them to vote either as they have previously, as they witness those around them voting, or for parties with a larger campaign presence. All

[78] This result is derived from Biddle (2022) which finds that 13.6% of voters in the 2022 federal election decided who to vote for *on election day* - a conservative definition of a swing voter.

three of these effects punish smaller parties and independent candidates who typically lack the established national voting bases which larger parties benefit from. Conversely, as a result of increased heuristics-based decision making, larger parties appear to be less sensitive in elevated temperatures, and, as an aggregate, appear to benefit from them.

VII.b Limitations & Future Extensions

One area where there is a lack of clarity is the channels through which elevated temperatures alter voting decision-making. We have proposed two primary channels - changes in cognition and issue salience - but have not distinguished between these channels. It is plausible that the vote-switching behaviour we witness arises not as a result of an increase in heuristics-based decision-making but instead is entirely driven by environmental issues being placed in the front of voters minds when the temperature is hot. In a future extension of this paper, we wish to create a measure of political parties environmental ”stance” - how anti- or pro-environment a political party is at an election[79]. A mock-up table which parties policies and political manifestos would be ranked according to is displayed in Appendix N. Accounting for this measure would allow for issue salience as a mechanism to be controlled for, isolating changes in cognition as the sole mechanism through elevated temperatures may induce vote-switching behaviour.

Additionally, all Australian state and territory elections also have routinely enforced compulsory voting systems. Applying our analysis of voting decision-making to these elections would both allow for an additional robustness check on the results found in

[79] This follows methodology used in Liao & Junco (2022) which utilised a similar variable for individual candidates in the United States.

this paper as well as an exploration into the impacts of temperature on voting-decision making in lower profile elections; elections where voters may have less prior information about parties and candidates when compared to highly publicised federal elections.

As individuals, we all make simple and complex decisions on a day-to-day basis as a part of our work and our daily lives. If, as is growing increasingly clear in the broader literature, our decision-making is sensitive to even modest increases in temperature, the implications for welfare losses from sub-optimal decision making is self-evident. As such, this is an area of study which warrants considerable additional focus, especially in the context of an increasingly warming world.

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IX Appendix

A. Monthly Average Temperatures

Figure 16: Monthly Average Maximum Daily Temperatures

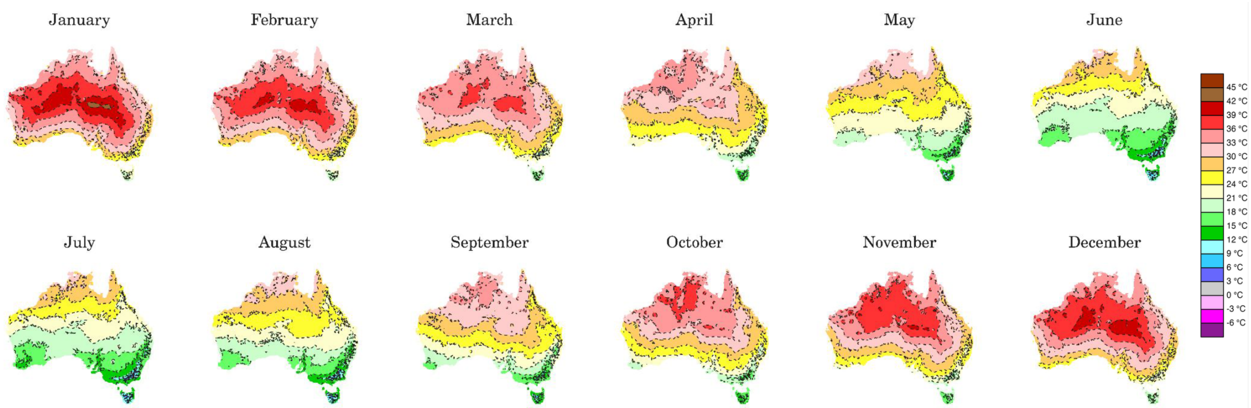
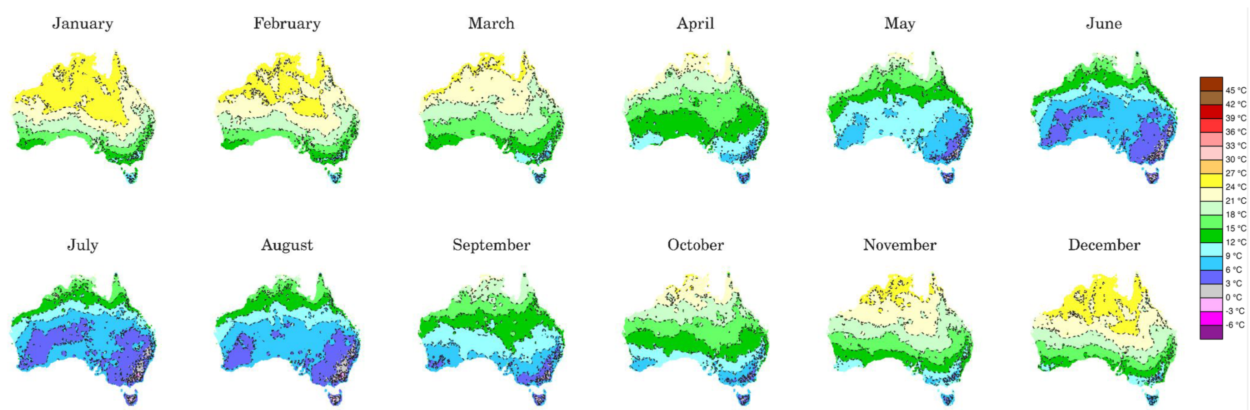


Figure 17: Monthly Average Minimum Daily Temperature



Note: Averages are based on data between 2001 - 2022

B. Absolute Temperatures

Figure 18: Maximum Daytime Temperature on Election Days

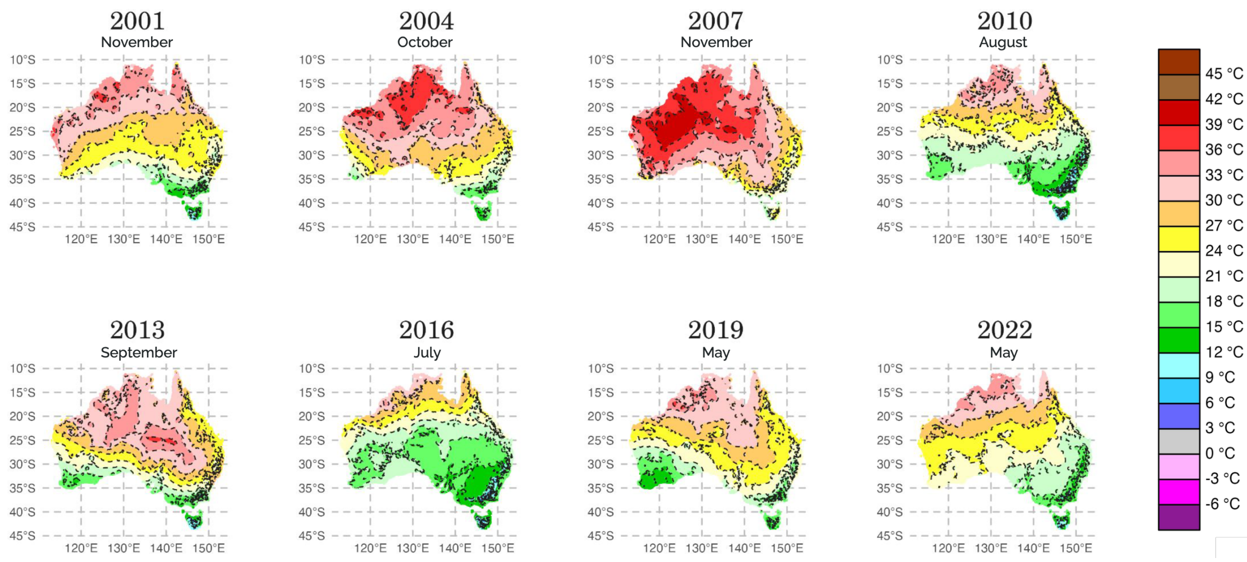
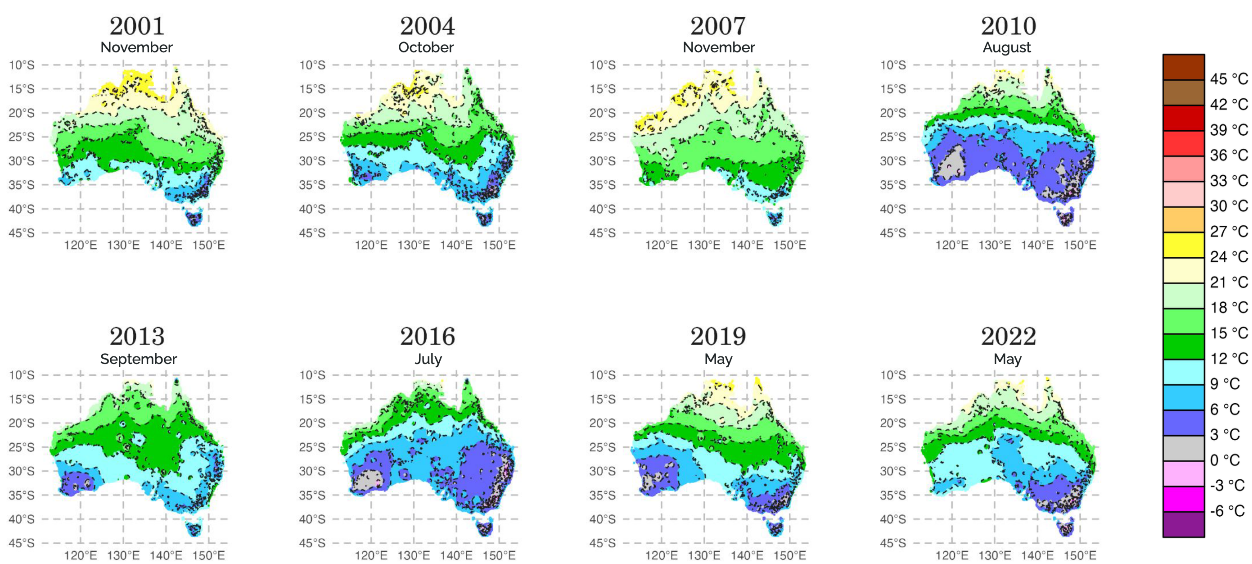


Figure 19: Minimum Overnight Temperature on Election Nights



Note: Overnight minimums are the minimum temperature recorded over the course of a day. We assume these occur the night before, following Carias et al. (2022).

C. Relative Temperatures

Figure 20: Relative Maximum Temperature on Election Days

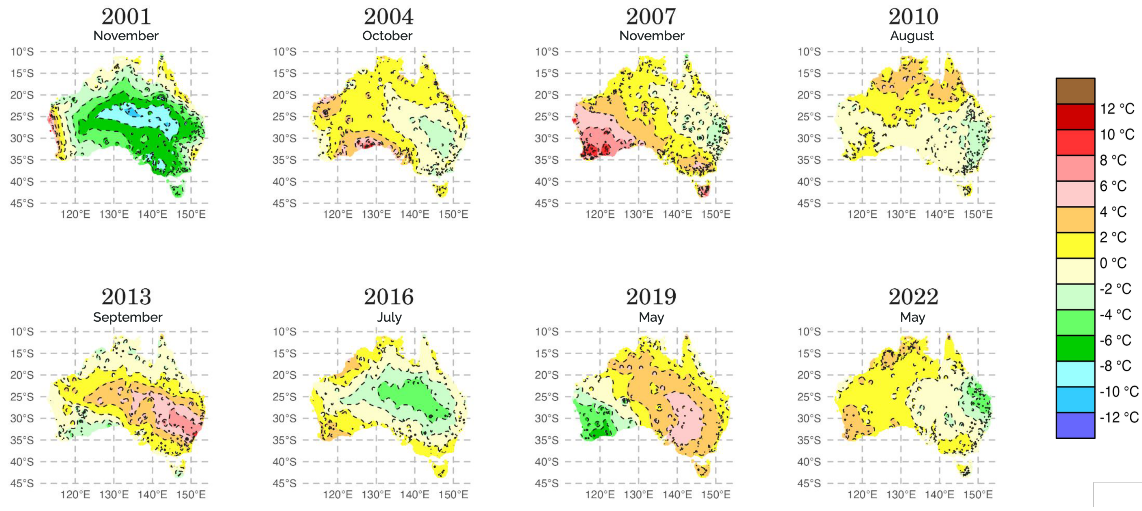
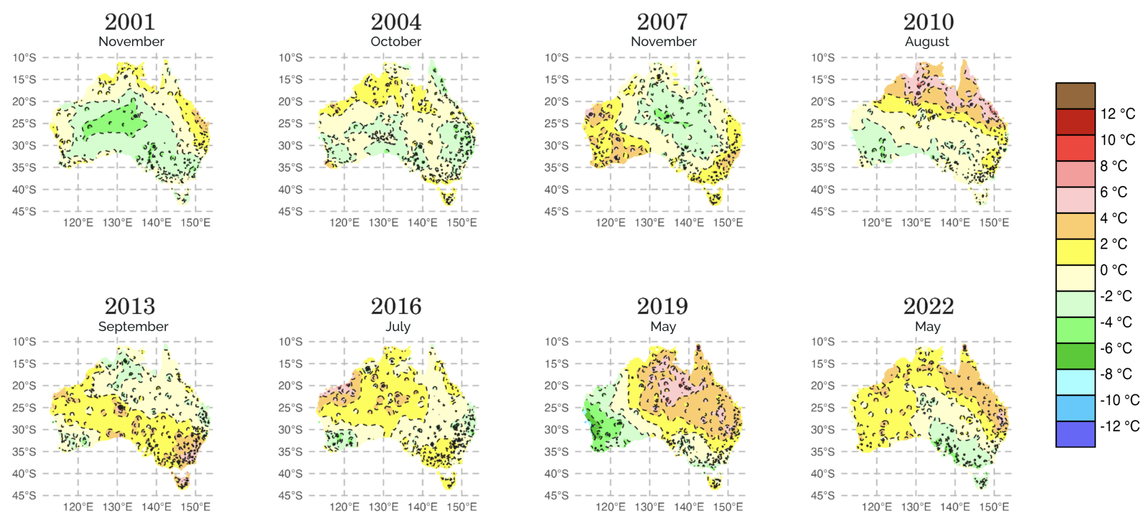


Figure 21: Relative Minimum Temperature on Election Nights



Note: Relative temperatures are the point difference between the *absolute temperature* and the monthly average temperature. Monthly average temperatures are the average expected temperature in each month based on data from 2001 - 2022.

D. Polling Place Voting Frequency Distributions

Figure 22: Distribution of total votes in each polling place - 2004 - 2022

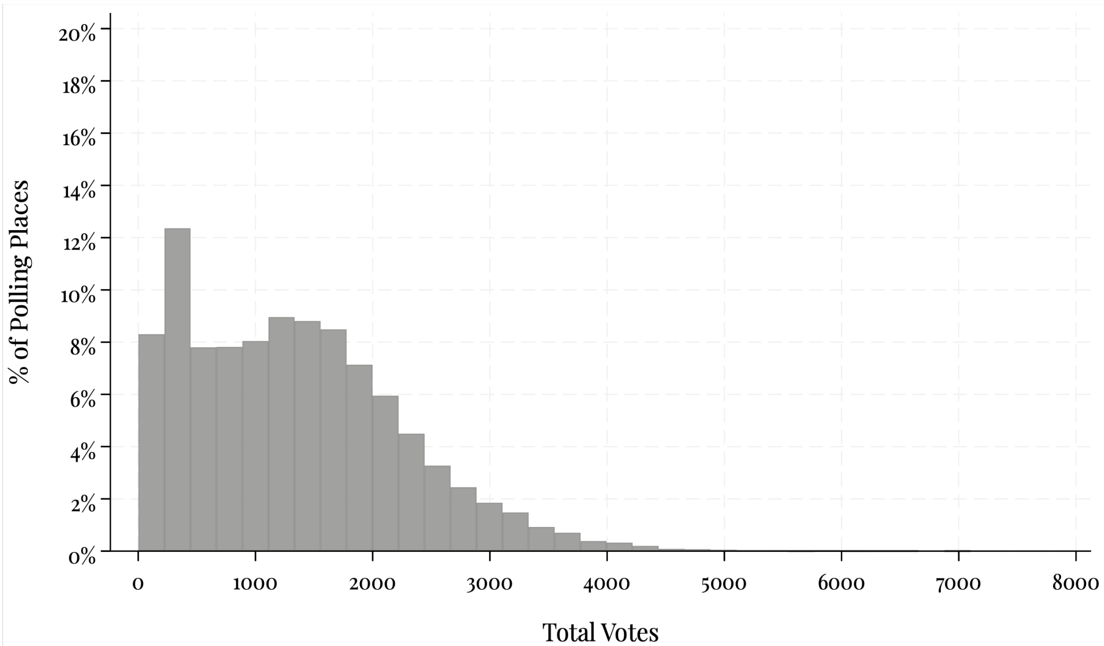
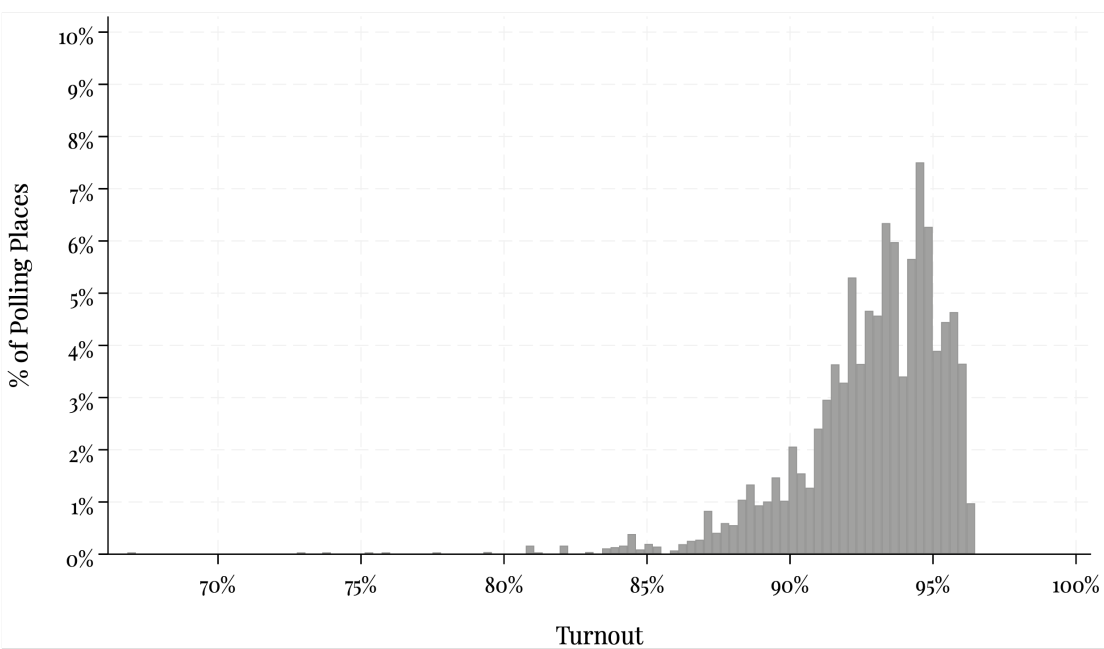


Figure 23: Distribution of turnout in each polling place - 2004 - 2022



E. Polling Place Descriptive Statistics

Table 8: Polling Place Level Descriptive Statistics

	Mean	Std. Dev.	Min	Max
Max Temperature (°C)	20.42	5.13	-6.48	43.53
Max Temperature Anomaly (°C)	0.13	2.73	-8.80	12.16
Min Temperature (°C)	8.78	4.74	-9.40	33.88
Min Temperature Anomaly (°C)	-0.19	2.47	-11.47	15.96
2-Week-Avg. Max Temperature (°C)	23.26	4.18	2.71	40.75
2-Week-Avg. Max Temperature Anomaly (°C)	2.97	3.94	-7.84	17.68
2-Week-Avg. Min Temperature (°C)	11.51	3.86	-3.12	32.54
2-Week-Avg. Min Temperature Anomaly(°C)	2.53	3.15	-9.96	16.97
Precipitation (mm)	1.43	5.08	-3.49	95.61
Total Votes	1342.21	907.11	2.00	7101.00
% Turnout	0.93	0.03	0.67	0.96
% Female	0.50	0.02	0.24	0.57
Median Age	39.48	5.30	18.00	65.00
% Speak Only English at Home	0.80	0.16	0.09	0.98
% Tertiary Education	0.45	0.08	0.10	0.79
Median Family Weekly Income (2021 AUD$)	1796.72	542.64	618.55	4648.00
Observations	36456			

Note: Data is from 2004 - 2022.

F. Political Party Funding

Table 9: Political Party Funding

Funding ($ Millions (AUD))	Mean	Std. Dev.	Min	Max
Liberal/National Coalition	245.61	79.87	151.53	359.46
Australian Labor Party	202.26	38.52	149.45	258.14
Australian Greens	33.13	19.27	9.35	56.93
Other Independents	64.89	66.08	11.55	117.22
Observations	7			

Note: Political party funding is aggregated at the national level - all individual state branches of political parties are summed. "Other Independents" are all other political parties aggregated - the specific number and names of these parties vary year-on-year. Data is from 2001 - 2022.

G. Detailed Temperature Descriptive Statistics

Table 10: Detailed Descriptive Statistics for Daytime Maximum Temperature

Percentages	Values (°C)		Values (°C)
1%	10.46	Min	-6.48
5%	12.98	Max	46.53
10%	14.24		
25%	16.68		
50%	19.75	Mean	20.36
75%	23.50	Variance	26.26
90%	27.33	Std. Dev.	5.12
95%	30.12	Kurtosis	3.00
99%	33.11	Skewness	0.46
Observations	37,919		

Note: Temperature data is for election days between 2004 - 2022.

Table 11: Detailed Descriptive Statistics for Daytime Maximum Temperature Anomalies

Percentiles	Values (°C)		Values (°C)
1%	-5.67	Min	-8.80
5%	-3.45	Max	12.10
10%	-2.69		
25%	-1.60		
50%	-0.23	Mean	0.15
75%	1.43	Std. Dev.	2.74
90%	3.58	Variance	7.52
95%	5.34	Skewness	0.88
99%	8.94	Kurtosis	4.56
Observations	37,919		

Note: Temperature data is for election days between 2004 - 2022.

Table 12: Detailed Descriptive Statistics for Overnight Minimum Temperature

Percentiles	Values (°C)		Values (°C)
1%	0.14	Min	-9.40
5%	2.47	Max	33.87
10%	3.36		
25%	5.22		
50%	7.89	Mean	8.73
75%	11.57	Std. Dev.	4.75
90%	15.91	Variance	22.53
95%	17.36	Skewness	0.63
99%	21.10	Kurtosis	3.05
Observations	37,919		

Note: Temperature data is for election days between 2004 - 2022.

Table 13: Detailed Descriptive Statistics for Overnight Minimum Temperature Anomaly

Percentiles	Values (°C)		Values (°C)
1%	-6.41	Min	-11.47
5%	-4.09	Max	15.95
10%	-3.28		
25%	-1.81		
50%	-0.17	Mean	-0.18
75%	1.46	Std. Dev.	2.47
90%	3.08	Variance	6.10
95%	3.86	Skewness	-0.02
99%	5.32	Kurtosis	3.16
Observations	37,919		

Note: Temperature data is for election days between 2004 - 2022.

H. Non-Voting Decisions - Overnight Graphs

Figure 24: % Turnout- Overnight Temperatures

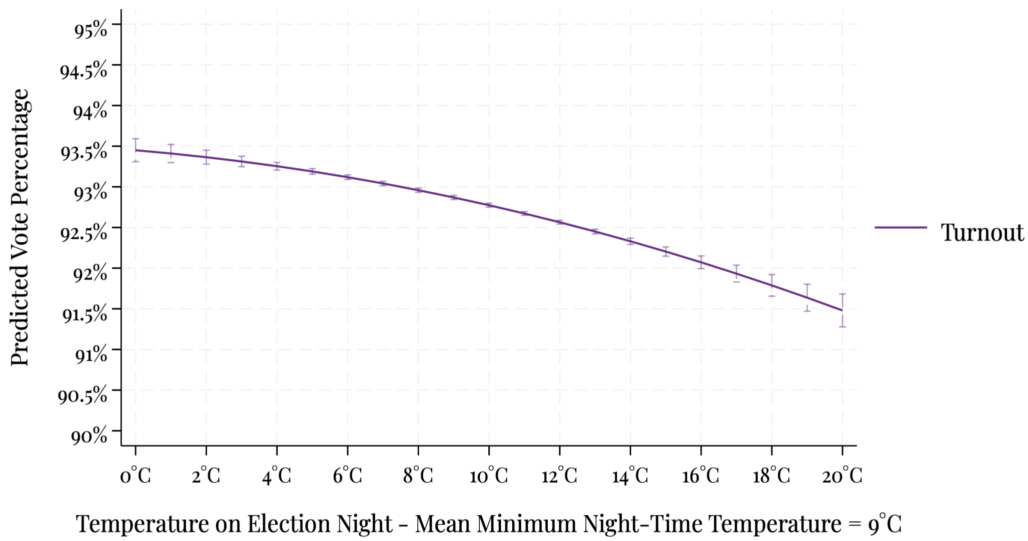
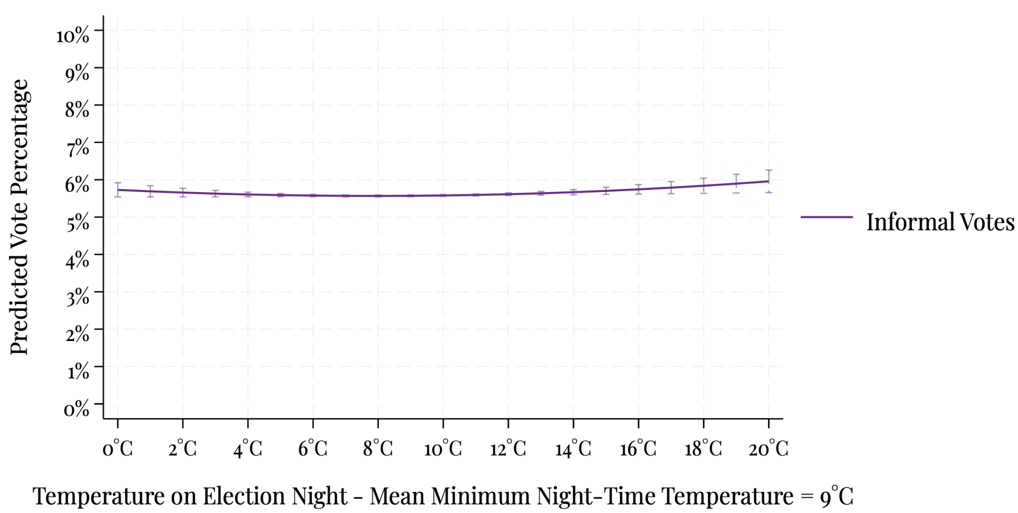


Figure 25: % Informal Voting- Overnight Temperatures



Note: Graphs are based on the average Australian polling place. Mean minimum overnight temperatures are equal to 9°C on nights before elections between 2004 - 2022. Deviations from the mean are plotted on the graph. Bars display 95% confidence intervals.

IX Appendix

Figure 26: % First Preferences for 1st Option- Overnight Temperatures

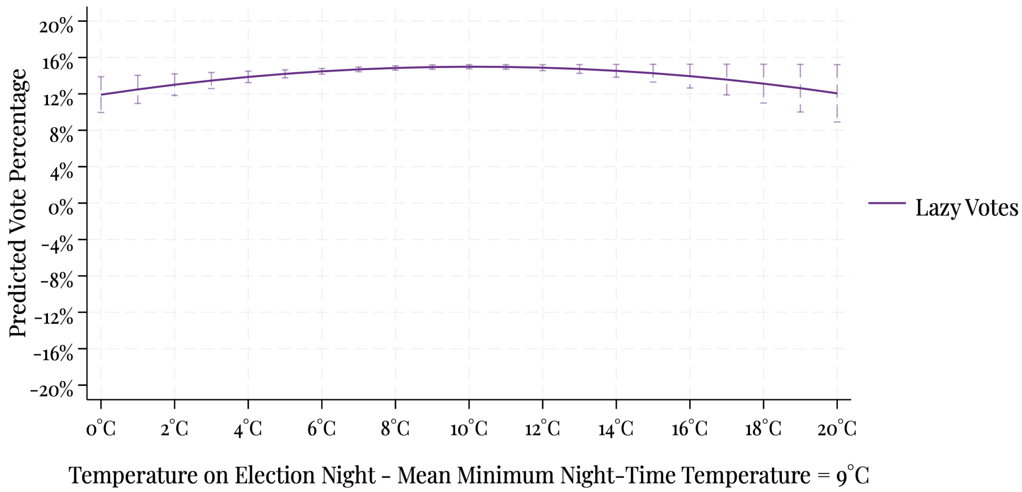
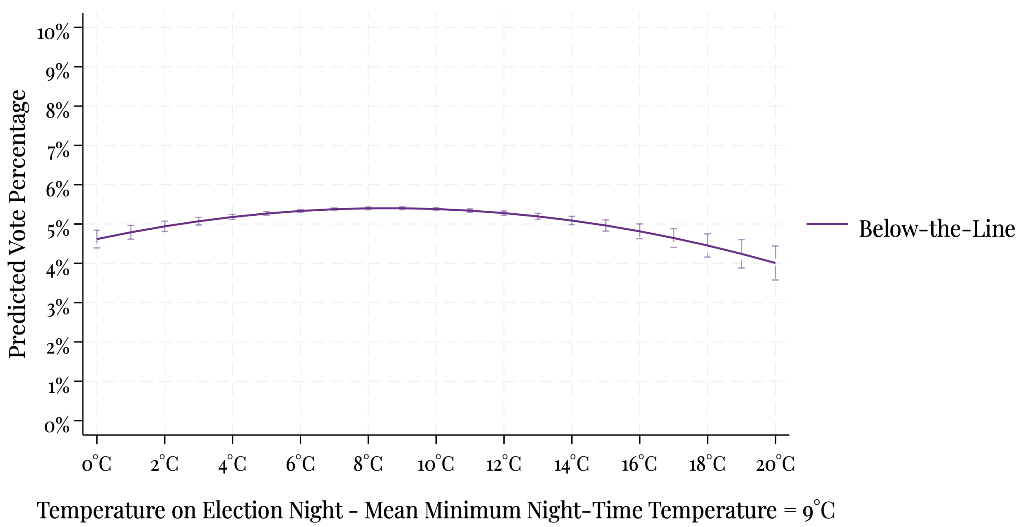


Figure 27: % Below-the-Line- Overnight Temperatures



Note: Graphs are based on the average Australian polling place. Mean minimum overnight temperatures are equal to 9°C on nights before elections between 2004 - 2022. Deviations from the mean are plotted on the graph. Bars display 95% confidence intervals.

I. Voting Decisions - Linear Specifications

Table 14: House of Representatives - Linear (Normalized)

	(1) LNP	(2) ALP	(3) GRN	(4) IND	(5) INF
Day Max Temperature (°C)	0.00523*	-0.01599***	0.00965***	0.00501	-0.00391***
	(0.00267)	(0.00203)	(0.00123)	(0.00330)	(0.00060)
Night Min Temperature (°C)	-0.03073***	0.01762***	0.01524***	0.00042	-0.00255***
	(0.00209)	(0.00174)	(0.00108)	(0.00254)	(0.00052)
Day Max Temp. Anomaly (°C)	-0.00277*	0.01041***	-0.00506***	-0.00636***	0.00379***
	(0.00165)	(0.00125)	(0.00080)	(0.00211)	(0.00037)
Night Min Temp. Anomaly (°C)	0.01862***	-0.00839***	-0.00715***	-0.00462***	0.00154***
	(0.00116)	(0.00092)	(0.00064)	(0.00138)	(0.00028)
Controls	Yes	Yes	Yes	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes	Yes	Yes	Yes
Election-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	36456	36456	36456	36456	36456

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 15: Senate - Linear (Normalized)

	(1) LNP	(2) ALP	(3) GRN	(4) IND
Day Max Temperature (°C)	0.00113	-0.00408**	0.00723***	-0.00428**
	(0.00170)	(0.00163)	(0.00106)	(0.00200)
Night Min Temperature (°C)	-0.03047***	0.03154***	0.01339***	-0.01446***
	(0.00140)	(0.00138)	(0.00089)	(0.00161)
Day Max Temp. Anomaly (°C)	-0.00378***	0.00378***	-0.00320***	0.00320**
	(0.00106)	(0.00100)	(0.00069)	(0.00132)
Night Min Temp. Anomaly (°C)	0.01266***	-0.01798***	-0.00466***	0.00998***
	(0.00078)	(0.00077)	(0.00050)	(0.00089)
Controls	Yes	Yes	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes	Yes	Yes
Election-Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	37940	37940	37940	37940

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Tables reports OLS estimates. Estimates are for elections between 2004 - 2022. The unit of observation are individual polling places recorded in each election year for each political party. Standard errors are reported in parenthesis and are cluster-robust within polling places. "Anomaly" variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

J. Voting Decisions - Overnight Graphs

Figure 28: House of Representatives: First-Preferences - Overnight Temperatures

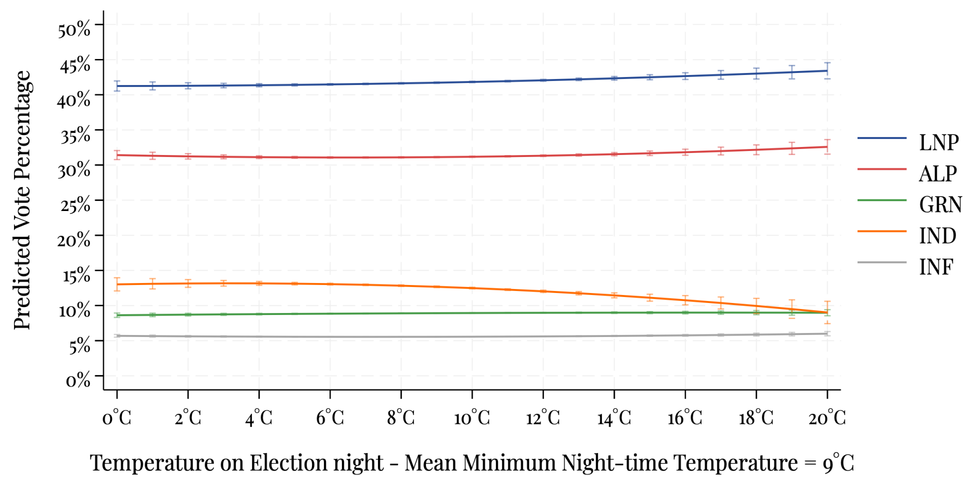
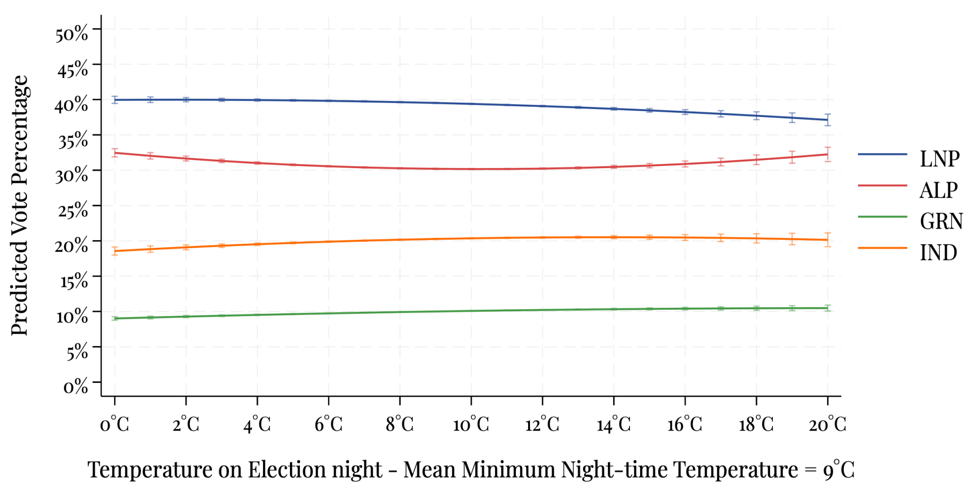


Figure 29: Senate: First-Preferences - Overnight Temperatures



Note: Graphs are based on the average Australian polling place. Mean maximum daytime temperatures are equal to 20°C on election days between 2004 - 2022. Deviations from the mean are plotted on the graph. Bars display 95% confidence intervals.

K. House of Representatives - Two-Party-Preferred

Table 16: Two-Party Preferred (Normalized)

	(1) Linear	(2) Non Linear
Day Max Temperature (°C)	0.59824***	-0.00050
	(0.18367)	(0.21417)
Night Min Temperature (°C)	-3.79510***	-3.75868***
	(0.15576)	(0.16791)
Day Max Temp. Anomaly (°C)	-0.37138***	-0.21307*
	(0.11008)	(0.12267)
Night Min Temp. Anomaly (°C)	2.11173***	2.06530***
	(0.08461)	(0.09041)
Day Max Temperature² (°C)		0.16127***
		(0.02758)
Night Min Temperature² (°C)		-0.19081***
		(0.03496)
Day Max Temp. Anomaly² (°C)		0.08288***
		(0.01834)
Night Min Temp. Anomaly² (°C)		0.05387***
		(0.02071)
Controls	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes
Election-Year Fixed Effects	Yes	Yes
Observations	37954	37954

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Outcome variable is the share of votes the LNP receives in a two-party run-off election between the LNP and the ALP.

Note: Table reports two-way fixed-effects estimates. Estimates are for elections between 2004 - 2022. The unit of observation are individual polling places recorded in each election year for each political party. Standard errors are reported in parenthesis and are cluster-robust within polling places. "Anomaly" variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

L. Two-Week Temperature Window - Regression Results

Table 17: House of Representatives - Non-Linear, Two-Week Specification (Normalized)

	(1) LNP	(2) ALP	(3) GRN	(4) IND	(5) INF
2Wk Day Max Temperature (°C)	0.00492**	-0.01215***	0.01004***	-0.00482*	0.00201***
	(0.00214)	(0.00169)	(0.00099)	(0.00265)	(0.00054)
2Wk Night Min Temperature (°C)	-0.03729***	0.01022***	0.00915***	0.01942***	-0.00150***
	(0.00207)	(0.00168)	(0.00099)	(0.00257)	(0.00049)
2Wk Day Max Temp. Anomaly (°C)	-0.00424**	0.01174***	-0.01153***	0.00382	0.00022
	(0.00195)	(0.00153)	(0.00092)	(0.00246)	(0.00045)
2Wk Night Min Temp. Anomaly (°C)	0.02760***	-0.01468***	-0.00533***	-0.01087***	0.00328***
	(0.00173)	(0.00129)	(0.00076)	(0.00214)	(0.00041)
2Wk Day Max Temperature² (°C)	-0.00637***	0.00722***	0.00168***	-0.00288***	0.00034**
	(0.00052)	(0.00054)	(0.00027)	(0.00069)	(0.00014)
2Wk Night Min Temperature² (°C)	0.00453***	0.00312***	0.00214***	-0.00983***	0.00005
	(0.00063)	(0.00052)	(0.00028)	(0.00074)	(0.00018)
2Wk Day Max Temp. Anomaly² (°C)	0.00391***	-0.00287***	0.00365***	-0.00563***	0.00093***
	(0.00035)	(0.00033)	(0.00018)	(0.00038)	(0.00011)
2Wk Night Min Temp. Anomaly² (°C)	-0.00375***	0.00027	-0.00234***	0.00620***	-0.00037***
	(0.00041)	(0.00033)	(0.00018)	(0.00056)	(0.00011)
Controls	Yes	Yes	Yes	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes	Yes	Yes	Yes
Election-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	36456	36456	36456	36456	36456

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Table reports two-way fixed-effects estimates. Estimates are for elections between 2004 - 2022. The unit of observation are individual polling places recorded in each election year for each political party. Standard errors are reported in parenthesis and are cluster-robust within polling places. "2Wk Anomaly" variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month (over a two-week average leading up to and including election days) at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

Table 18: Senate - Non-Linear, Two-Week Specification (Normalized)

	(1) LNP	(2) ALP	(3) GRN	(4) IND
2Wk Day Max Temperature (°C)	-0.00824***	-0.00127	0.00586***	0.00365**
	(0.00148)	(0.00131)	(0.00083)	(0.00150)
2Wk Night Min Temperature (°C)	-0.02943***	0.02978***	0.00872***	-0.00906***
	(0.00137)	(0.00133)	(0.00079)	(0.00148)
2Wk Day Max Temp. Anomaly (°C)	0.00697***	0.00596***	-0.00888***	-0.00405***
	(0.00131)	(0.00125)	(0.00078)	(0.00151)
2Wk Night Min Temp. Anomaly (°C)	0.01631***	-0.02905***	-0.00638***	0.01911***
	(0.00109)	(0.00115)	(0.00068)	(0.00136)
2Wk Day Max Temperature² (°C)	-0.00574***	0.00316***	0.00451***	-0.00194***
	(0.00041)	(0.00042)	(0.00027)	(0.00047)
2Wk Night Min Temperature² (°C)	-0.00287***	0.00088*	0.00051**	0.00148***
	(0.00044)	(0.00049)	(0.00025)	(0.00056)
2Wk Day Max Temp. Anomaly² (°C)	-0.00071**	-0.00509***	0.00338***	0.00243***
	(0.00029)	(0.00027)	(0.00013)	(0.00030)
2Wk Night Min Temp. Anomaly² (°C)	0.00050*	0.00326***	-0.00061***	-0.00315***
	(0.00028)	(0.00029)	(0.00016)	(0.00034)
Controls	Yes	Yes	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes	Yes	Yes
Election-Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	37940	37940	37940	37940

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Table reports two-way fixed-effects estimates. Estimates are for elections between 2004 - 2022. The unit of observation are individual polling places recorded in each election year for each political party. Standard errors are reported in parenthesis and are cluster-robust within polling places. "2Wk Anomaly" variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month (over a two-week average leading up to and including election days) at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

M. Sensitivity Tests - Regression Results

M.a. Queensland

Table 19: House of Representatives - First-Preferences; No QLD

	(1) LNP	(2) ALP	(3) GRN	(4) IND	(5) INF
Day Max Temperature (°C)	0.00142	0.00450*	-0.00869***	0.00865*	-0.00589***
	(0.00350)	(0.00274)	(0.00167)	(0.00475)	(0.00078)
Night Min Temperature (°C)	-0.04607***	0.00270	0.03181***	0.01715***	-0.00558***
	(0.00289)	(0.00203)	(0.00142)	(0.00351)	(0.00069)
Day Max Temp. Anomaly (°C)	-0.00026	0.00025	0.00612***	-0.01026***	0.00416***
	(0.00202)	(0.00161)	(0.00100)	(0.00281)	(0.00045)
Night Min Temp. Anomaly (°C)	0.02199***	0.00367***	-0.01895***	-0.01081***	0.00410***
	(0.00173)	(0.00114)	(0.00088)	(0.00207)	(0.00037)
Day Max Temperature² (°C)	0.00349***	-0.00118***	-0.00165***	-0.00162***	0.00096***
	(0.00043)	(0.00037)	(0.00020)	(0.00055)	(0.00011)
Night Min Temperature² (°C)	-0.00409***	0.00287***	-0.00066***	0.00264***	-0.00076***
	(0.00075)	(0.00053)	(0.00025)	(0.00067)	(0.00016)
Day Max Temp. Anomaly² (°C)	-0.00056*	-0.00130***	0.00094***	0.00119**	-0.00027***
	(0.00033)	(0.00026)	(0.00016)	(0.00046)	(0.00009)
Night Min Temp. Anomaly² (°C)	0.00157***	0.00022	-0.00067***	-0.00174***	0.00062***
	(0.00041)	(0.00030)	(0.00017)	(0.00054)	(0.00010)
Controls	Yes	Yes	Yes	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes	Yes	Yes	Yes
Election-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	29519	29519	29519	29519	29519

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Tables reports OLS estimates. Estimates are for elections between 2004 - 2022. The unit of observation are individual polling places recorded in each election year for each political party. Standard errors are reported in parenthesis and are cluster-robust within polling places. "Anomaly" variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

Table 20: Senate - First-Preferences; No QLD

	(1) LNP	(2) ALP	(3) GRN	(4) IND
Day Max Temperature (°C)	-0.01363***	0.01566***	-0.00869***	0.00666**
	(0.00224)	(0.00198)	(0.00140)	(0.00263)
Night Min Temperature (°C)	-0.02823***	0.01743***	0.02866***	-0.01786***
	(0.00168)	(0.00152)	(0.00110)	(0.00192)
Day Max Temp. Anomaly (°C)	0.00531***	-0.00612***	0.00622***	-0.00541***
	(0.00132)	(0.00115)	(0.00085)	(0.00161)
Night Min Temp. Anomaly (°C)	0.00991***	-0.00424***	-0.01404***	0.00837***
	(0.00096)	(0.00087)	(0.00066)	(0.00102)
Day Max Temperature² (°C)	0.00259***	-0.00180***	-0.00256***	0.00177***
	(0.00029)	(0.00028)	(0.00018)	(0.00032)
Night Min Temperature² (°C)	-0.00354***	0.00518***	-0.00199***	0.00036
	(0.00049)	(0.00048)	(0.00023)	(0.00039)
Day Max Temp. Anomaly² (°C)	-0.00115***	-0.00020	0.00150***	-0.00015
	(0.00022)	(0.00020)	(0.00014)	(0.00027)
Night Min Temp. Anomaly² (°C)	0.00026	0.00203***	0.00057***	-0.00286***
	(0.00025)	(0.00024)	(0.00015)	(0.00029)
Controls	Yes	Yes	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes	Yes	Yes
Election-Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	30999	30999	30999	30999

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Tables reports OLS estimates. Estimates are for elections between 2004 - 2022. The unit of observation are individual polling places recorded in each election year for each political party. Standard errors are reported in parenthesis and are cluster-robust within polling places. "Anomaly" variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

M.b. Pre-Poll

Table 21: House of Representatives - First-Preferences; No 2022, 2019

	(1) LNP	(2) ALP	(3) GRN	(4) IND	(5) INF
Day Max Temperature (°C)	0.01849***	-0.00752***	-0.00061	-0.00388	-0.00647***
	(0.00357)	(0.00267)	(0.00138)	(0.00460)	(0.00076)
Night Min Temperature (°C)	-0.02652***	0.00169	0.02205***	0.00661***	-0.00383***
	(0.00230)	(0.00176)	(0.00112)	(0.00253)	(0.00058)
Day Max Temp. Anomaly (°C)	-0.00659***	0.00379**	0.00370***	-0.00644**	0.00555***
	(0.00217)	(0.00170)	(0.00091)	(0.00291)	(0.00047)
Night Min Temp. Anomaly (°C)	0.01663***	-0.00423***	-0.01205***	-0.00345**	0.00311***
	(0.00131)	(0.00094)	(0.00061)	(0.00145)	(0.00032)
Day Max Temperature^2 (°C)	-0.00210***	-0.00123***	-0.00263***	0.00493***	0.00103***
	(0.00046)	(0.00036)	(0.00019)	(0.00058)	(0.00011)
Night Min Temperature^2 (°C)	0.00319***	0.00804***	-0.00113***	-0.00891***	-0.00120***
	(0.00061)	(0.00062)	(0.00020)	(0.00074)	(0.00015)
Day Max Temp. Anomaly^2 (°C)	0.00160***	0.00086***	0.00050***	-0.00231***	-0.00064***
	(0.00033)	(0.00026)	(0.00015)	(0.00044)	(0.00009)
Night Min Temp. Anomaly^2 (°C)	-0.00110***	0.00055*	-0.00208***	0.00193***	0.00069***
	(0.00039)	(0.00032)	(0.00016)	(0.00050)	(0.00010)
Controls	Yes	Yes	Yes	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes	Yes	Yes	Yes
Election-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	26040	26040	26040	26040	26040

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Tables reports OLS estimates. Estimates are for elections between 2004 - 2022. The unit of observation are individual polling places recorded in each election year for each political party. Standard errors are reported in parenthesis and are cluster-robust within polling places. ”Anomaly” variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

Table 22: Senate - First-Preferences; No 2022, 2019

	(1) LNP	(2) ALP	(3) GRN	(4) IND
Day Max Temperature (°C)	0.02075***	-0.00068	-0.00690***	-0.01316***
	(0.00212)	(0.00186)	(0.00112)	(0.00210)
Night Min Temperature (°C)	-0.02952***	0.00956***	0.01671***	0.00325**
	(0.00152)	(0.00135)	(0.00090)	(0.00143)
Day Max Temp. Anomaly (°C)	-0.01065***	-0.00095	0.00779***	0.00381***
	(0.00136)	(0.00117)	(0.00073)	(0.00139)
Night Min Temp. Anomaly (°C)	0.01753***	-0.00940***	-0.00869***	0.00056
	(0.00090)	(0.00077)	(0.00052)	(0.00080)
Day Max Temperature² (°C)	0.00060**	0.00082***	-0.00335***	0.00193***
	(0.00028)	(0.00028)	(0.00018)	(0.00027)
Night Min Temperature² (°C)	0.00030	0.00540***	-0.00121***	-0.00449***
	(0.00035)	(0.00039)	(0.00017)	(0.00033)
Day Max Temp. Anomaly² (°C)	-0.00317***	0.00038*	0.00103***	0.00176***
	(0.00022)	(0.00020)	(0.00012)	(0.00023)
Night Min Temp. Anomaly² (°C)	-0.00021	0.00086***	-0.00150***	0.00084***
	(0.00028)	(0.00025)	(0.00013)	(0.00030)
Controls	Yes	Yes	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes	Yes	Yes
Election-Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	27109	27109	27109	27109

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Tables reports OLS estimates. Estimates are for elections between 2004 - 2022. The unit of observation are individual polling places recorded in each election year for each political party. Standard errors are reported in parenthesis and are cluster-robust within polling places. "Anomaly" variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

M.c. Number of Independents

Table 23: House of Representatives - First-Preferences; No. of Independents

	(1) IND
Day Max Temperature (°C)	0.01310***
	(0.00392)
Night Min Temperature (°C)	-0.00078
	(0.00274)
Day Max Temp. Anomaly (°C)	-0.00851***
	(0.00236)
Night Min Temp. Anomaly (°C)	-0.00472***
	(0.00153)
Day Max Temperature² (°C)	-0.00034
	(0.00045)
Night Min Temperature² (°C)	-0.00098**
	(0.00048)
Day Max Temp. Anomaly² (°C)	-0.00069*
	(0.00036)
Night Min Temp. Anomaly² (°C)	-0.00124***
	(0.00039)
Ind_Count	0.01152***
	(0.00028)
Controls	Yes
Polling-Place Fixed Effects	Yes
Election-Year Fixed Effects	Yes
Observations	36456

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Tables reports OLS estimates. Estimates are for elections between 2004 - 2022. The unit of observation are individual polling places recorded in each election year. Standard errors are reported in parenthesis and are cluster-robust within polling places. ”Anomaly” variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place. ”Ind_Count” is a variable which counts the number of independent candidates running in an election year, in a polling place.

Table 24: Senate - First-Preferences; No. of Independents

	(1) IND
Day Max Temperature (°C)	-0.00374
	(0.00243)
Night Min Temperature (°C)	-0.01835***
	(0.00180)
Day Max Temp. Anomaly (°C)	0.00139
	(0.00149)
Night Min Temp. Anomaly (°C)	0.01173***
	(0.00100)
Day Max Temperature² (°C)	0.00150***
	(0.00029)
Night Min Temperature² (°C)	0.00084**
	(0.00034)
Day Max Temp. Anomaly² (°C)	-0.00023
	(0.00022)
Night Min Temp. Anomaly² (°C)	-0.00123***
	(0.00026)
Ind_Count	0.00202***
	(0.00011)
Controls	Yes
Polling-Place Fixed Effects	Yes
Election-Year Fixed Effects	Yes
Observations	37940

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Tables reports OLS estimates. Estimates are for elections between 2004 - 2022. The unit of observation are individual polling places recorded in each election year. Standard errors are reported in parenthesis and are cluster-robust within polling places. "Anomaly" variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place. "Ind_Count" is a variable which counts the number of independent candidates running in an election year, in a polling place.

M.d. Precipitation

Table 25: House of Representatives - First-Preferences; No Precipitation

	(1) LNP	(2) ALP	(3) GRN	(4) IND	(5) INF
Day Max Temperature (°C)	0.01953***	-0.00215	0.00069	-0.01073**	-0.00735***
	(0.00316)	(0.00264)	(0.00149)	(0.00431)	(0.00079)
Night Min Temperature (°C)	-0.02170***	0.01211***	0.02347***	-0.00834***	-0.00554***
	(0.00248)	(0.00203)	(0.00127)	(0.00276)	(0.00069)
Day Max Temp. Anomaly (°C)	-0.01086***	0.00416***	0.00009	0.00125	0.00536***
	(0.00183)	(0.00156)	(0.00090)	(0.00253)	(0.00046)
Night Min Temp. Anomaly (°C)	0.01479***	-0.00460***	-0.01290***	-0.00047	0.00317***
	(0.00130)	(0.00104)	(0.00070)	(0.00144)	(0.00035)
Day Max Temperature² (°C)	0.00031	-0.00165***	-0.00195***	0.00189***	0.00140***
	(0.00043)	(0.00036)	(0.00019)	(0.00054)	(0.00011)
Night Min Temperature² (°C)	0.00048	0.00342***	-0.00061***	-0.00178***	-0.00152***
	(0.00057)	(0.00046)	(0.00019)	(0.00052)	(0.00015)
Day Max Temp. Anomaly² (°C)	0.00049*	-0.00072***	0.00138***	-0.00081**	-0.00035***
	(0.00029)	(0.00024)	(0.00014)	(0.00040)	(0.00008)
Night Min Temp. Anomaly² (°C)	0.00092***	-0.00001	-0.00032***	-0.00125***	0.00067***
	(0.00032)	(0.00025)	(0.00012)	(0.00042)	(0.00008)
Controls	Yes	Yes	Yes	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes	Yes	Yes	Yes
Election-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	30438	30438	30438	30438	30438

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Tables reports OLS estimates. Estimates are for elections between 2004 - 2022. The unit of observation are individual polling places recorded in each election year. Standard errors are reported in parenthesis and are cluster-robust within polling places. "Anomaly" variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

Table 26: Senate - First-Preferences; No Precipitation

	(1) LNP	(2) ALP	(3) GRN	(4) IND
Day Max Temperature (°C)	0.00494**	-0.00072	-0.00221	-0.00201
	(0.00212)	(0.00205)	(0.00136)	(0.00269)
Night Min Temperature (°C)	-0.02728***	0.02612***	0.02239***	-0.02123***
	(0.00178)	(0.00169)	(0.00113)	(0.00205)
Day Max Temp. Anomaly (°C)	-0.00290**	0.00095	0.00150*	0.00045
	(0.00126)	(0.00119)	(0.00082)	(0.00163)
Night Min Temp. Anomaly (°C)	0.01113***	-0.01417***	-0.00986***	0.01290***
	(0.00092)	(0.00088)	(0.00060)	(0.00107)
Day Max Temperature² (°C)	0.00134***	-0.00032	-0.00284***	0.00182***
	(0.00029)	(0.00026)	(0.00016)	(0.00031)
Night Min Temperature² (°C)	-0.00004	0.00219***	-0.00206***	-0.00008
	(0.00037)	(0.00036)	(0.00019)	(0.00038)
Day Max Temp. Anomaly² (°C)	-0.00215***	0.00017	0.00222***	-0.00023
	(0.00020)	(0.00020)	(0.00012)	(0.00027)
Night Min Temp. Anomaly² (°C)	0.00087***	0.00029	0.00017	-0.00133***
	(0.00021)	(0.00022)	(0.00011)	(0.00028)
Controls	Yes	Yes	Yes	Yes
Polling-Place Fixed Effects	Yes	Yes	Yes	Yes
Election-Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	31691	31691	31691	31691

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Tables reports OLS estimates. Estimates are for elections between 2004 - 2022. The unit of observation are individual polling places recorded in each election year. Standard errors are reported in parenthesis and are cluster-robust within polling places. "Anomaly" variables are constructed by taking the difference between the maximum/minimum daily temperature recorded and the average expected maximum/minimum temperature expected in an election month at each polling place. The individual controls are for median age, median family weekly income, percentage exclusively speaking English at home, percentage female, and percentage graduated tertiary education in each polling place.

N. Environmental Stance Scorecard Mock-Up

Figure 30: Environmental Stance Scorecard

Air, Lands, & Forests							
Oceans							
Wildlife							
Water Quality							
Pollutants and Chemicals							
Energy Policy							
Transport							
Climate Change							

Strongly Anti-Environment	Anti-Environment	Weakly Anti-Environment	Neutral / Status Quo	Weakly Pro-Environment	Pro-Environment	Strongly Pro-Environment
-3	-2	-1	0	1	2	3

Note: Scorecard is based on methodology used in Liao & Junco (2022). Political parties would be assigned an average score across all policies they outline in their pre-election party manifestos. Independents' score would be an aggregate of the scores of the three largest independent parties in each election by first-preferences in the House of Representatives.