Democratic tornadoes? County-level evidence on the influence of local disasters on US gubernatorial elections*

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Abstract

Do tornadoes influence gubernatorial elections in the United States? I study this question using county-level election data in the context of deadly tornadoes. I find that Democrats benefit from deadly tornadoes: vote shares for Democratic candidates are .43 p.p. higher in counties that experienced a deadly tornado since the last gubernatorial election. The effect increases with treatment intensity. Deadly tornadoes within 12 months before the election and tornadoes causing more fatalities trigger a stronger response by the electorate. Based on a spatial model of voting with valence, I present suggestive evidence that voters' political preferences shift towards the policy platform offered by Democratic candidates after the crisis experience.

Keywords: US gubernatorial elections; Natural Disasters; Tornadoes; Voter Behavior; Policy Preferences; Causal Inference; Event Study Design

JEL Codes: D72; H84; P43; Q54

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1 Introduction

Natural disasters influence electoral outcomes. The literature provides three reasons: First, voters might be irrational and blame the incumbent for the negative shock (e.g., Wolfers et al., 2002; Achen and Bartels, 2002, 2016; Leigh, 2009; Healy et al., 2010; Huber et al., 2012). Second, voters might reward or punish the incumbent depending on the incumbent's disaster relief effort (e.g., Healy and Malhotra, 2010; Bechtel and Hainmueller, 2011; Gasper and Reeves, 2011; Cole et al., 2012; Neugart and Rode, 2021; Cooperman, 2022). Third, voters might learn new information from the incumbent's crisis response and update their beliefs about the incumbent (e.g., Ashworth et al., 2018; Cerqua et al., 2021; Masiero and Santarossa, 2021). I provide evidence for a fourth reason how natural disasters influence electoral outcomes: The shock itself changes voters' preferences.

I study how deadly tornadoes influenced gubernatorial elections in the United States from 1960 to 2020. I combine county-level election data with geospatial information on the incidence of tornadoes. Similar to Deryugina and Marx (2021), I only use lethal tornadoes, allowing me to identify events that affected populated areas and caused, on average, tens of millions of USD worth of damage. Tornadoes make useful natural experiments because (i) they vary over space and time, (ii) are limited in their geographic scope, and (iii) are short-lived and unpredictable. The National Oceanic and Atmospheric Administration (NOAA) maintains a database capturing tornado-related fatalities, injuries, and property damage of each reported tornado since 1950. I employ an event study design that compares election outcomes of counties with a deadly tornado experience since the last election to counties without in the same state. My identifying assumptions are that (i), conditional on a host of fixed effects and controls, tornado fatalities are unrelated to any unobservable determinants of voting behavior and (ii) voters do not anticipate tornadoes and change their voting behavior before the event. I find no pre-trends in voting behavior, supporting the parallel trends assumption.

My main result is that Democrats benefit from deadly tornadoes. The Democratic vote share increased by 0.43 percentage points (p.p.) after a deadly tornado. The effect increases with treatment intensity. Deadly tornadoes within 12 months before the election and tornadoes causing more fatalities trigger a stronger response by the electorate. In my baseline event study specification, I only include counties experiencing their first deadly tornado since 1950 in the treatment group. Inference does not

change when I allow for multiple treatments. An advantage of the event study design is the possibility of studying treatment effect persistence. In the baseline specification of my event study, voters react immediately and strongly to a deadly tornado. The effect partly carries over to subsequent elections. This finding is similar to Bechtel and Hainmueller (2011), who find a 25% effect size persistence in the second election after the 2002 Elbe flooding in Germany.

My study setup allows me to examine the underlying mechanism of why Democrats benefit from deadly tornadoes in gubernatorial elections. I control for governor incumbency effects by investigating open seat elections. The baseline results are confirmed when sampling challenger races only, indicated by an increase of the two-party vote share for the Democratic candidate of more than half a p.p. in treated counties. To account for potential party incumbency effects, I present separate results for treated counties under a Democratic and Republican governor. Deadly tornadoes do not seem to influence voting behavior when a Republican governor is in power. Under a Democratic governor, the effect size is about twice as large as in the baseline specification. These results suggest that two mechanisms work either in conjunction or against each other. First, and in line with the literature, I observe a party incumbency mechanism: The candidate of the incumbent party benefits from the governor's disaster response in the subsequent election. Second, I still observe a shift in voters' preferences toward the policy platform offered by Democratic candidates. My evidence suggests that the strength of the two mechanisms is about equal in magnitude.

Federal intervention is a threat to identification when investigating the effect of local disasters on electoral outcomes. To rule out that the increase in the Democratic vote share is driven by a comparative advantage of Democratic governors in attracting federal disaster relief money, I only consider deadly tornadoes without a presidential disaster declaration. Treatment intensity as measured by a tornado's devastating impact decreases, but the inference does not change for the subsample analysis.

My study contributes to the literature on voters' responses to negative exogenous shocks, such as natural disasters and economic shocks.[1] Empirically, results are mixed. So far, most studies focus on incumbent vs. challenger races and not on the party affiliation of candidates. Several studies find that the incumbent's electoral fortune

[1]Natural disasters: Abney and Hill (1966), Achen and Bartels (2002), Healy et al. (2010), Healy and Malhotra (2010), Bechtel and Hainmueller (2011), Gasper and Reeves (2011), Cole et al. (2012), Chen (2013), Heersink et al. (2017), Heersink et al. (2020), Masiero and Santarossa (2021), Cerqua et al. (2021), Neugart and Rode (2021), and Cooperman (2022). Economic shocks: Wolfers et al. (2002), Ebeid and Rodden (2006), Leigh (2009), and Kayser and Peress (2012).

is unaffected by an exogenous shock (e.g., Abney and Hill, 1966; Ebeid and Rodden, 2006; Kayser and Peress, 2012), many find negative effects (e.g., Wolfers et al., 2002; Achen and Bartels, 2002, 2016; Leigh, 2009; Healy et al., 2010; Gasper and Reeves, 2011; Cole et al., 2012; Heersink et al., 2017), and some find a positive effect of exogenous shocks on the incumbent's vote share (e.g., Bechtel and Hainmueller, 2011; Chen, 2013; Masiero and Santarossa, 2021; Neugart and Rode, 2021). Little is known about how the candidates' party affiliation and policy platform influence voters' response to natural disasters.[2] I depart from the existing literature by providing evidence for a new mechanism linking negative exogenous shocks to a change in voting behavior via altered policy preferences.

My study also contributes to the literature on experience-based preference formation. Older evidence on how natural disasters affect risk aversion is mixed (see Chuang and Schechter (2015) for a literature review). However, more recent studies consistently suggest that people become more risk averse after experiencing floods (Cameron and Shah, 2015), earthquakes (Cameron and Shah, 2015; Hanaoka et al., 2018), tsunamis (Cassar et al., 2017), cyclones (Brown et al., 2018), rainfall-shocks (Di Falco and Vieider, 2022), or any weather-related disaster (Bourdeau-Brien and Kryzanowski, 2020; Johar et al., 2022).

Methodologically, my study advances research on the granular spatial analysis of voter behavior. Few studies have analyzed nationwide electoral behavior at the county level over a long time period.[3] This is largely due to limitations in data availability, especially for non-federal elections (Darmofal and Strickler, 2019). Most researchers rely on congressional districts to examine the distribution of voters within a state.[4] Amlani and Algara (2021) compiled a comprehensive dataset of county-level US gubernatorial election outcomes, which I use in this study.

The remainder of this paper is organized as follows. In the next section, I introduce a spatial model of voting with valence and give some empirical context. Section 3 provides background information on US governors, US gubernatorial elections, and tornadoes. In Section 4, I present the data and show descriptive evidence. I formalize

[2] An exception is Heersink et al. (2020), who examine the effects of Hurricane Sandy on the 2012 presidential election and show that those counties previously supporting Obama reacted far more positively to disaster damage than those that had earlier opposed him ("partisan retrospection").

[3] If studies employ county-level electoral data, it is mostly from US presidential elections (see, for example, Frendreis et al., 1990; Knack and Kropf, 2003; Gomez et al., 2007; Ambrosius, 2016; Darmofal and Strickler, 2019).

[4] One notable exception is Hopkins (2018), who analyzes, among other things, county-level election returns from US gubernatorial elections starting as early as 1928.

my empirical strategy in Section 5 and present my results in Section 6. Section 7 discusses my findings. Section 8 concludes.

2 Theory and empirical context

Crisis experiences change preferences. The change in preferences might change voters' preferred policy. Equation 1 gives a spatial model of voting with valence, where voter i's utility from supporting candidate j is some combination of policy preferences on issue k and the candidate's valence attributes V_j.[5]

$$u_{i,j,k} = -(1-w)\underbrace{(|\theta_{j,k} - \theta^*_{i,k}|)^{\alpha}}_{\text{Policy}} + w\underbrace{(|V_j - V^*_i|)^{\beta}}_{\text{Valence}} \quad , \tag{1}$$

$\theta_{j,k} - \theta^*_{i,k}$ predicts that voter i's utility is declining in the distance between the voter's preferred policy ($\theta^*_{i,k}$) and the policy platform of candidate j on issue k ($\theta_{j,k}$) (spatial component). α parameterizes the shape of the decline. $V_j - V^*_i$ predicts that voter i's utility is declining in the distance between the voter's preferred valence attributes of the next governor (V^*_i) and the candidate's valence attributes (V_j) (valence component). Valence attributes are non-policy candidate qualities, such as charisma, competence, and trustworthiness.[6] β parameterizes the shape of the decline. w is a parameter assigning relative weights to the policy and the valence component of the model.

Studies in political science have focused on different parts of the model. One branch of the literature suggests that crisis-induced anxiety shifts the voter's preferred policy toward "protective policies", benefiting conservative candidates whose policy platforms are more likely to emphasize these dimensions (Stenner, 2005; Getmansky and Zeitzoff, 2014; Albertson and Gadarian, 2015; Campante et al., 2020). However, disentangling the policy and the valence component is nontrivial as conservative candidates may also benefit because voters prioritize "leadership" and "strength", valence attributes more associated with conservatism, in times of crises (Holman et al., 2016, 2019).

My empirical investigation builds on the model in Equation 1 and allows me to exclude a valence mechanism because I compare treated counties to non-treated coun-

[5] Spatial and valence models of voting are central theories explaining voting behavior (Downs, 1957; Stokes, 1963; Manin, 1995; Krehbiel, 1998; Ansolabehere and Snyder, 2000; Sanders et al., 2011). This model is based on Bisbee and Honig (2022).

[6] Valence theory identifies three principal heuristics that voters employ: Evaluation of party leaders' competence, attitudes about which party can handle the most important problems facing the country best, and party identification (Sanders et al., 2011).

ties within the same state. The candidates running for the gubernatorial office are the same across intrastate treatment and control groups. It is unlikely that the candidates' valence characteristics (V_j) change after a deadly tornado because tornadoes are local disasters limited in their geographic scope. However, even if the candidates' valence characteristics change after a deadly tornado, the change equally affects treated and control counties.

Voters in treated counties might change their preferred valence attributes of the next governor (V_i^*) after a deadly tornado. Intuitively, they would place relatively more weight on leadership qualities in their electoral decision compared to voters in control counties. My study setup mitigates concerns that the results are driven by the model's valence component because my observation period spans 60 years with almost 1,000 US gubernatorial elections. It is plausible that individual valence characteristics are close to randomly distributed among Democratic and Republican candidates in my sample. If anything, Republicans possess more valence qualities that are favored in times of crises, which would downward-bias the magnitude of the effect (see Holman et al., 2016, 2019). I further subject my results to several robustness checks and show that my findings hold in open seat elections. Individual valence characteristics of the incumbent cannot influence the electoral results of open seat elections. I also find that results hold when splitting the sample to account for a party incumbency mechanism by investigating elections with Democratic and Republican incumbency separately.

Holding the model's valence component constant across voters in treated and control counties leaves the policy component to explain differences in voting behavior between treated and non-treated voters. The policy component again consists of two parts: The voter's preferred policy ($\theta_{i,k}^*$) and the policy platform of candidate j ($\theta_{j,k}$). It is unlikely that a deadly tornado in a county affects the state-wide policy platform of the gubernatorial candidates. However, even a change in the policy platform of candidate j ($\theta_{j,k}$) after a deadly tornado would affect voters' utility in treated and control counties equally, given that voters in treated and control counties are not systematically different from each other before the deadly tornado.[7]

What is left is the voter's preferred policy ($\theta_{i,k}^*$) to explain differences in voting behavior between treated and non-treated voters. Recent studies have shown that risk aversion increases after natural disasters (Cameron and Shah, 2015; Cassar et al., 2017; Hanaoka et al., 2018; Brown et al., 2018; Bourdeau-Brien and Kryzanowski, 2020;

[7]The pre-treatment trends of my event study design show that voters in treated and control counties do not differ in their voting behavior before the treatment (see Section 6).

Di Falco and Vieider, 2022; Johar et al., 2022). Increased risk aversion makes voters demand more social insurance and increased protection from a negative economic shock. The model of political cycles by Pastor and Veronesi (2020) predicts that agents elect Democrats – the party promising more social security and redistribution – when risk aversion is high.[8] Therefore, my hypothesis to be tested empirically is:

Hypothesis 1. *Democratic candidates benefit from deadly tornadoes in US gubernatorial elections.*

I expect that the voter's preferred policy changes after experiencing a deadly tornado. Voters demand more social insurance and better protection from a negative economic shock. The voter's preferred policy moves closer toward the policy platform offered by the Democratic candidate because Democrats promise more social insurance. Vice versa, the voter's preferred policy moves further away from the policy platform of the Republican candidate because the Republican party advocates for a smaller government and less social security. On average, the treated voter increases her utility by voting for the Democratic candidate.

3 Background information

3.1 State government and the governor

State governments shape economic policy-making. They set tax rates, decide on state spending and running deficits, establish minimum wages, cap the maximum weekly unemployment benefits, and so on. In line with the partisan theory (Hibbs, 1977; Alesina, 1987), Democratic state governments spend relatively more, run larger deficits, adopt more encompassing Medicare coverage, were more active in promoting universal care, and redistributed income more than Republican governments (see Potrafke (2018) for a survey).

Governors head the state government and have far-reaching powers (Beyle et al., 2008), including budgetary and veto powers, executive orders, and informal powers (see Bernick (2016) for a survey). They are also responsible for appointing officials and

[8] Pastor and Veronesi (2020) also show that Democratic voters are more risk averse. I propose that the increase in the Democratic two-party vote share after a deadly tornado is driven by an increase in risk aversion and a higher demand for social insurance.

judges, and make legislative proposals. Governors thus have significant influence over the direction of the state budget and policy environment, and powers may go as far as circumventing the state legislature (Cahan, 2019). Term limits of US governors play a crucial role in identifying the importance of the governor for state policy-making. Besley and Case (1995) find that governors facing a binding term limit behave differently than those who are able to run again.

The partisan affiliation of governors is highly relevant for policy-making. For instance, only Republican governors have rejected the expansion of Medicaid as part of the Affordable Care Act (Haeder and Weimer, 2013; Barrilleaux and Rainey, 2014). If a Democrat is in office, taxes, spending, and other policy instruments respond to a binding term limit. Similarly, Sieg and Yoon (2017) show that the governor's ideology has a large impact on taxes. Fiscal conservatives prefer lower expenditures and lower taxes than fiscal liberals.

The governor is, by the state constitution, the most prominent actor in response to a disaster. He decides on mobilizing state resources to mitigate the adverse effects of a disaster. If the required disaster response efforts surpass the state's available resources, the governor may opt to request additional resources from the federal government. The decision of whether to request a disaster declaration directly from the president lies with the governor. The *Stafford Act* (1988) determines the process: After a disaster, the state's governor initiates a preliminary damage assessment. If a disaster appears to overwhelm local and state capacities, he can send an official disaster declaration request to the president (United States Congress, 1988).[9]

3.2 US gubernatorial elections

US gubernatorial elections take place in November.[10] Every year, the governorship is up for election in a subset of the states: 36 states hold their gubernatorial election in midterm years, nine states hold them in presidential election years, and five hold them in odd-numbered years.[11] These election schedules have changed little over the past 60

[9]The Disaster Relief Act Amendments of 1974 (Public Law 93-288) codified the procedures of the presidential disaster declaration process. According to Lindsay and McCarthy (2015, p. 20), the fundamentals of the process have been in place since 1950 and "changed very little over time".

[10]In the rare case of a special or recall election, the election might not take place in November (see following footnote). In general, incumbents cannot decide when elections take place.

[11]Exception: Special elections and recall elections. In these cases, the winner finishes the current term – a new election will still be held according to the state's fixed schedule (Cahan, 2019). Recent examples of special elections are Utah 2010 (incumbent resigned), West Virginia 2011 (incumbent

years.[12]

A Governor's term lasts four years, except for New Hampshire and Vermont, where terms are two years.[13] Most governors were subject to term limits between 1960 and 2020. Gubernatorial term limits are prescribed by the state constitution.[14] If states have a gubernatorial term limit, it is mostly two terms, except for Virginia, where incumbents cannot stand for re-election. In a few states, governors can also serve a maximum of eight out of 12 or 16 years. Some states offer the possibility of re-eligibility after four years out of office. Term limits increase the number of challenger races.[15]

3.3 Tornadoes

A tornado is a "mobile, destructive vortex of violently rotating winds having the appearance of a funnel-shaped cloud and advancing beneath a large storm system" (Oxford English Dictionary, 2022). According to the National Weather Service, tornadoes are "nature's most violent storms" (National Oceanic and Atmospheric Administration, 2015). They can cause fatalities and devastate a neighborhood in seconds. Tornadoes can be more than three kilometers in diameter and stay on the ground for more than 100 kilometers. Wind speeds can attain more than 480 kilometers per hour. However, most tornadoes are much weaker and do not harm people or structures.

Tornadoes are very common in the United States. While tornadoes disproportionally affect regions of the South and Midwest known as "Tornado Alley", they have been observed in every US state. Tornadoes make useful natural experiments because they (i) vary over space and time, (ii) are limited in their geographic scope, and (iii) are short-lived and unpredictable.

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died), and Oregon (incumbent resigned). Recent examples of recall elections are California 2003 (electricity crisis), Wisconsin 2012 (incumbent's restrictions on unions), and California 2021 (incumbent's personal behavior and leadership).

[12] Changes in election timing were Florida 1964 and Illinois 1976, switching from presidential election years to midterm years, and Louisiana 1975 moving back one year relative to presidential election years.

[13] Switched from two-year to four-year terms: Massachusetts, Michigan, Minnesota, Nebraska, and North Dakota in the 1960s; Iowa, Kansas, Louisiana, New Mexico, South Dakota, Texas, and Wisconsin in the 1970s; Arkansas in 1986; Rhode Island in 1994.

[14] An exception is Wyoming, where term limits are given by its statutes.

[15] As the name suggests, challenger races or open seat elections are elections without an incumbent candidate.

4 Data

4.1 US gubernatorial elections

My data on US gubernatorial elections come from Amlani and Algara (2021). They provide county-level data on presidential, senatorial, and gubernatorial elections from 1872 to 2020. The main data sources are raw county-level election returns from *Congressional Quarterly* and the *United States Historical Election Returns* provided by the Inter-university Consortium for Political and Social Research (ICPSR Study 1). The data captures 98.5% (2461/2499) of all gubernatorial elections.[16]

I only employ data from 1960 onward to ensure that counties in the control group did not experience a deadly tornado for at least 10 years.[17] Excluding the years before 1960 also mitigates concerns due to (i) major changes in the timing of gubernatorial elections and term limits in the years before 1960 (Besley and Case, 1995), (ii) changes to the Democrat's and Republican's party ideology in the immediate years following World War II, and (iii) data quality and completeness.[18] I do not consider first-round gubernatorial elections if there is a general election run-off. This is relatively rare and only affects the gubernatorial elections in Arizona (1991) and Louisiana (1979, 1991, 2003, 2015, 2019). The final dataset includes 812 gubernatorial elections in 48 states.[19]

The data includes information on the date of the election, state, the name of the county, candidates' names, the total number of votes, the number of votes for the Democratic candidate, the number of votes for the Republican candidate, the Democratic two-party vote share, and incumbency status.[20] Panel A of Table 1 shows county-

[16]Of the 38 gubernatorial elections missing, only 10 would be of interest to this study as they are conventional two-party contested elections. These include Nebraska 1866, Texas 1866, New Jersey 1877, New Hampshire 1878, Virginia 1889, Vermont 1892, California 1898, Kentucky 1900 (special), Delaware 1928, and Kentucky 1954 (Amlani and Algara, 2021).

[17]See Section 5 for the estimation strategy and Section 6 for the pre-treatment trend results.

[18]No two-party contested election is missing, and data is available for most counties.

[19]I exclude US gubernatorial elections in Alaska and Hawaii because county-level electoral data is incomplete. However, no deadly tornado struck a county in Alaska or Hawaii between 1950 and 2020. Some non-two-party contested elections are not available in the data, such as those with major independent candidates (e.g., Maine 1974, Utah 1992, and Texas 2006), major third-party candidates (e.g., New York 1990, Minnesota 1998, and Colorado 2010), missing Democratic or Republican candidates (e.g., Alabama 1962, Tennessee 1966, and Illinois 1986), and multiple candidates from a major party (Alabama 1970 and Louisiana 1987). I include all available non-two-party contested elections in my analysis, as third-party or independent candidates affect election outcomes in treated and comparison group counties equally and do not introduce bias into my results.

[20]The Democratic two-party vote share is the number of votes for the Democratic candidate relative to the total number of votes for the Democratic and the Republican candidate.

Table 1 County-level summary statistics

Variable	Mean	Median	Std. Dev.	Max.	Obs.
Panel A: Gubernatorial election outcomes					
Total votes	23,880.45	6,833	75,537.07	2,941,101	49,549
Dem. votes	11,713.55	3157	41,324.83	2,114,699	49,549
Rep. votes	11,537.54	3366	34,572.56	1,389,995	49,549
Dem. two-party vote share (in %)	48.86	48.10	16.32	100.00	49,549
Panel B: County characteristics					
Total population	74,444.58	21,006	254,252.3	9,818,605	49,549
Size (sqkm)	2,523.27	1,658.42	3,387.02	52,072.34	49,549

Notes: Panel A reports the following county-level summary statistics for US gubernatorial election outcomes: Total votes, Democratic votes, Republican votes, and the Democratic two-party vote share. Panel B reports summary statistics for the counties' population and the counties' size. Source: Amlani and Algara (2021).

level summary statistics for total votes, Democratic votes, Republican votes, and the Democratic two-party vote share. On average, the number of total votes per county is 23,880, while much fewer voters are cast in the majority of counties. The mean of Democratic votes is higher than the mean of Republican votes. The opposite is true for the median. This suggests that voters in rural areas with fewer votes per county vote relatively more Republican, whereas voters in counties with many voters (mostly urban counties) vote relatively more for Democratic candidates.

Amlani and Algara (2021) also report population totals and the size of each county.[21] Examining population levels and density is useful because it describes how rural or urban a county is. Panel B of Table 1 gives summary statistics for the total population and the size of a county. 74,444 people lived in an average county between 1950 and 2020. A county's size is, on average, 2,523 square miles, about eight times the City of New York.

[21] The population data is taken from the US census and updated every 10 years.

4.2 Tornadoes

My data on tornadoes come from the NOAA Tornado Database, which tracks the path of every known tornado since 1950.[22] The database reports the number of fatalities and injuries for each tornado, along with the counties affected and the date and time when it occurred. The majority of tornadoes reported between 1950 and 2020 caused no known property damage, fatalities, or injuries (see Panel A of Table 2). It is unlikely that these tornadoes have triggered a response by the electorate. In line with Deryugina and Marx (2021), I restrict my sample to tornadoes that are most likely to have prompted a response by voters: Those that caused at least one fatality.[23]

Table 2 Tornado-level summary statistics

Variable	Mean	Median	Std. Dev.	Max.	Obs.
Panel A: All tornadoes					
Fatalities	0.08	0	1.39	158	66,244
Injuries	1.34	0	17.47	1,740	66,244
Property damage (millions USD)	3.11	0	52.43	2,800	8,438
Panel B: Deadly tornadoes					
Fatalities	4.20	1	9.36	158	1,681
Injuries	46.32	11	119.04	1,740	1,681
Property damage (millions USD)	50.74	2	251.34	2,800	327

Notes: The table reports fatalities, injuries, and property damage for all (deadly) tornadoes in Panel A (B). Data on property damage is taken from Deryugina and Marx (2021) and covers the years 2002 to 2017. Source: National Oceanic and Atmospheric Administration (2022).

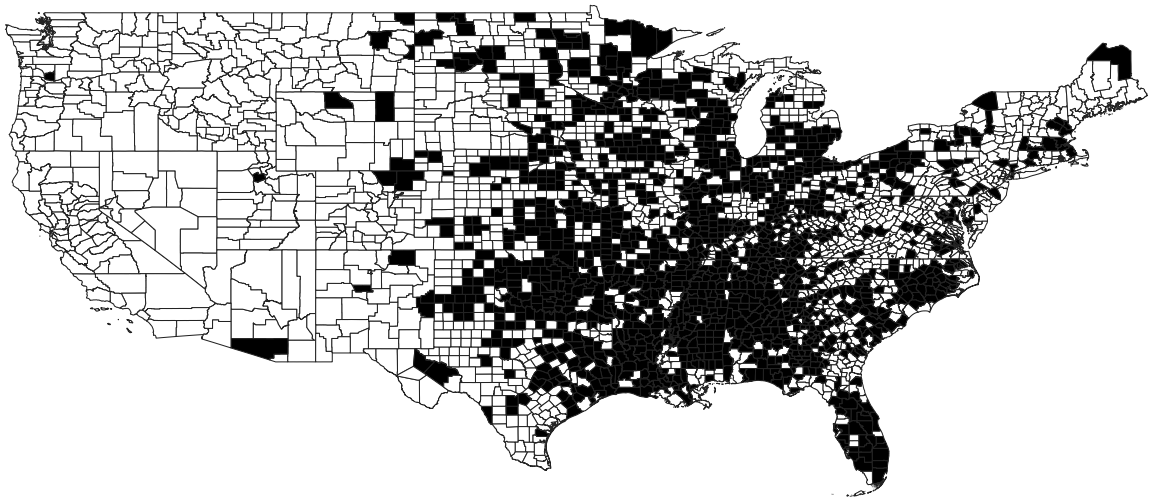
Panel B of Table 2 shows summary statistics for the 1,681 deadly tornadoes in my sample: On average, a deadly tornado kills more than four people, insures 46, and

[22] Available from https://www.spc.noaa.gov/wcm/#data.

[23] The database also provides damage estimates. However, these measures are very imprecise and thus much noisier measures of severity than fatalities. Uncertain damage is recorded as zero damage in the data, making it impossible to distinguish uncertain damage from true zeroes. While injuries may also indicate severity, no distinction is made between minor and major injuries, making them less comparable than fatalities.

causes more than 50 million USD in property damage. The mean (median) amount of federal disaster aid per tornado fatality was 13.3 (2.98) million USD in 2008 dollars (Deryugina and Marx, 2021).[24]

Figure 1 Deadly tornadoes in the United States, 1950–2020



Notes: The figure shows all reported deadly tornadoes in the United States from 1950 to 2020 by county. Counties which experienced a deadly tornado between 1950 and 2020 are colored black. Counties with no deadly tornado between 1950 and 2020 are colored white. Data for Alaska and Hawaii are not reported because no deadly tornado struck a county in Alaska or Hawaii between 1950 and 2020. Source: National Oceanic and Atmospheric Administration (2022).

Figure 1 displays the counties affected by at least one deadly tornado between 1950 and 2020. 1,389 counties in my dataset experienced at least one deadly tornado.[25] This is equivalent to more than 40% of all US counties. Almost half of the counties hit by a deadly tornado were struck multiple times. In total, my dataset includes 2,499 county observations with a deadly tornado. Most deadly tornadoes only affect one county and even the most devastating ones rarely pass through more than a couple of counties. While deadly tornadoes strike most often in the central United States, an area known as "Tornado Alley", they occurred in 42 states during the observation period.

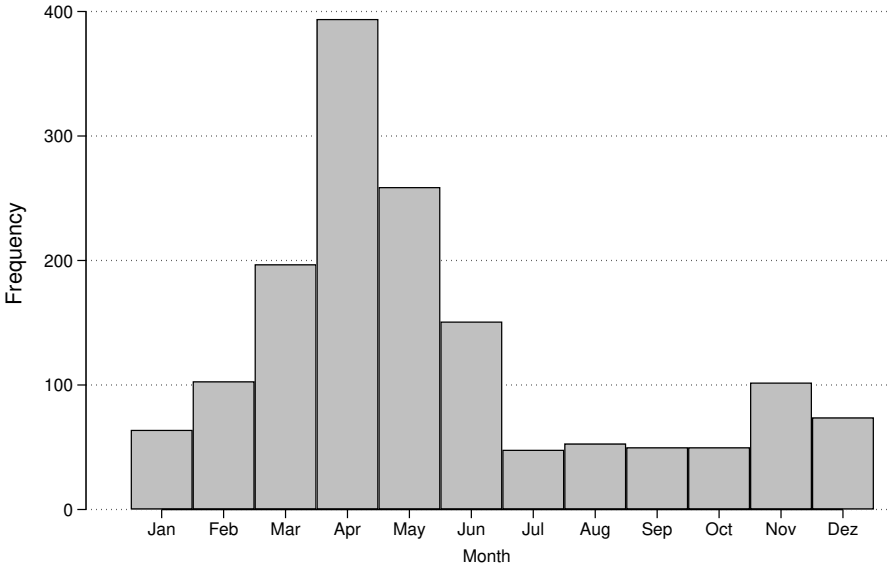
Figure 2 shows the frequency of deadly tornadoes by month. Deadly tornadoes can

[24] Deryugina and Marx (2021) use FEMA data (`https://www.fema.gov/disasters`). They divide the total state-year disaster aid for tornado-related disasters by the corresponding number of tornado fatalities.

[25] See Table D.2 in the Appendix for the frequency of deadly tornadoes by county. The total number of counties in my dataset is 3,108).

strike at any time of the year. However, they occur most frequently around April and May, with NOAA defining the so-called "tornado season", depending on the region, as the months from March to July. Comparably few deadly tornadoes happen in fall and therefore in very close proximity to state or federal elections. This setup allows me to capture the true effect of a deadly tornado on voter behavior. If a deadly tornado strikes in an election year, it most likely occurs four to eight months before the election. Voters have time to digest the effects of the tornado, allowing their preferences to change, which then translates into a shift in their preferred policy. Concurrently, the timeline leaves little to no room for idiosyncratic confounding events that affect the treated county differently than other state counties. My event study design further mitigates concerns that effects are driven by confounding events.

Figure 2 Deadly tornadoes by month



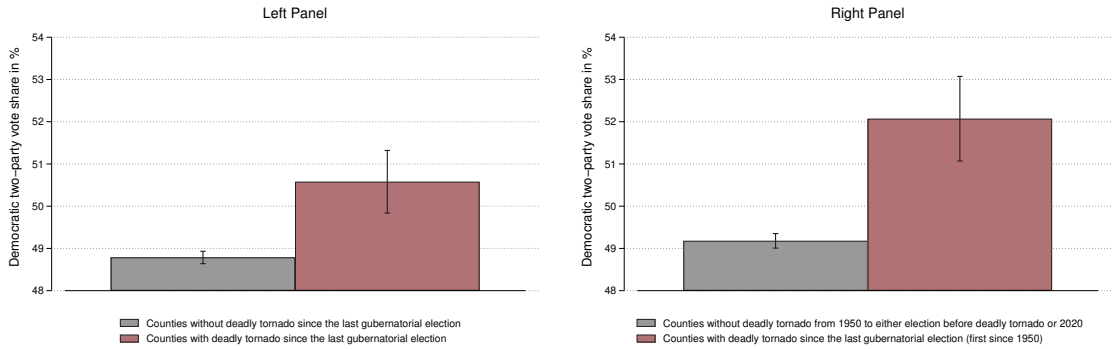
Notes: The figure shows all reported deadly tornadoes in the United States from 1950 to 2020 by month. Source: National Oceanic and Atmospheric Administration (2022).

4.3 Descriptive statistics

Figure 3 illustrates a comparison in gubernatorial electoral outcomes between counties which experienced a deadly tornado since the last gubernatorial election and counties

which did not experience a deadly tornado since the last gubernatorial election. The left panel shows the Democratic two-party vote share in gubernatorial elections for counties with a deadly tornado since the last gubernatorial election (red) and counties without a deadly tornado since the last gubernatorial election (grey). The difference in the means between the two groups is 1.793 p.p., implying that voters in counties hit by a deadly tornado before the gubernatorial election are more likely to vote for the Democratic candidate than voters in counties with no deadly tornado before the election. The difference between the two groups is statistically significant (see Table D.1, Panel A in the Appendix for t-test results).

Figure 3 Voting behavior in counties with and without a deadly tornado since the last gubernatorial election



Notes: DT = deadly tornado. The left panel shows the Democratic two-party vote share in gubernatorial elections for counties with a DT since the last gubernatorial election (red) and counties without a DT since the last gubernatorial election (grey). The right panel shows the Democratic two-party vote share in gubernatorial elections only for counties which experienced a DT since the last gubernatorial election with that tornado being the first lethal one since 1950 (red) and counties which did not experience a DT from 1950 to either the election before the DT or the end of the sample period in 2020 (grey).

The right panel of Figure 3 shows the Democratic two-party vote share in gubernatorial elections only for counties which experienced a deadly tornado since the last gubernatorial election, with that tornado being the first lethal one since 1950 (red) and counties which did not experience a deadly tornado from 1950 to either the election before the deadly tornado or the end of the sample period in 2020 (grey). The difference in the means between the two groups is even larger than before, suggesting that counties which experience a deadly tornado for the first time respond even stronger by voting relatively more Democratic (the difference in means between the two groups is 2.891 p.p. and statistically significant, see Panel B of Table D.1 in the Appendix for

t-test results).

5 Estimation strategy

My empirical strategy is designed to examine whether deadly tornadoes have influenced US gubernatorial election outcomes. This is a situation with staggered treatment timing and the possibility of multiple events per unit. For identification, I follow von Bismarck-Osten et al. (2022) and propose a difference-in-difference design, assuming that the true causal model for the Democratic two-party vote share (Y_{ct}) in county c in election t is

$$Y_{ct} = \alpha_c + \beta_t + \tau_{ct} D_{ct} + \varepsilon_{ct} \quad . \tag{2}$$

In Equation 2, α_c and β_t capture the county and election fixed effects (absorbing time-invariant county characteristics and election-specific characteristics, such as candidate quality). $D_{ct} = 1[t \geq E_c]$ is the indicator that the county is "treated" (i.e., a deadly tornado hit the county), where in the baseline E_c is the election when county c is treated for the first time since 1950. Further, τ_{ct} captures the "treatment effect" that is, the impact of the deadly tornado on the Democratic two-party vote share, while ε_{ct} is the residual such that $E[\varepsilon_{ct}|\alpha_c, \beta_t, D_{ct}] = 0$. The parallel trends assumption in the model predicts that, absent the treatment, the expected outcome is $\alpha_c + \beta_t$. Equation 2 also allows for heterogeneous treatment effects by county and election.

To derive the treatment effect, I apply the "imputation" estimator by Borusyak et al. (2022). Estimating Equation 2 as a conventional event study, meaning by ordinary least squares (OLS) with two-way fixed effects and some lags and leads of treatment, produces unreliable estimates in presence of effect heterogeneity.[26] To overcome biased estimators in event study designs, recent studies propose several robust estimators (e.g., De Chaisemartin and d'Haultfoeuille, 2020; Callaway and Sant'Anna, 2021; Sun and Abraham, 2021). The "imputation" estimator has some attractive properties, such as efficiency, transparency, and conservative standard errors. I compute the estimator using the *did_imputation* Stata command provided by Borusyak et al. (2022).

I follow von Bismarck-Osten et al. (2022) in constructing the imputation estimator in three steps. First, the county and election fixed effects α_c and β_t are estimated

[26] See Borusyak and Jaravel (2017); Strezhnev (2018); De Chaisemartin and d'Haultfoeuille (2020); Goodman-Bacon (2021).

by OLS on the subsample of untreated observations only ($D_{ct} = 0$) using data until the election before the deadly tornado in each county. Second, I obtain an unbiased estimate $\hat{\tau}_{ct} = Y_{ct} - \hat{\alpha}_c - \hat{\beta}_t$ for each treated observation. While treatment effects for each election and county cannot be estimated consistently, Borusyak et al. (2022) show that averages of $\hat{\tau}_{ct}$ across many observations can, given appropriate regularity conditions. Any such average of interest can therefore be reported in the third step. Here, I deviate from von Bismarck-Osten et al. (2022) in that I am not interested in the average effect on a number n of elections after the treatment but only in the average effect on the first election after the treatment:[27]

$$\hat{\tau} = \frac{1}{|C|} \sum_{c \in C} \hat{\tau}_{c,E_c} \quad , \tag{3}$$

where C is the set of counties c observed in period E_c. The imputation estimator leverages all difference-in-differences contrasts between some county c in period E_c relative to periods before treatment, $t < E_c$ (reference periods) and relative to other counties which have not been treated yet by E_c.

In my baseline specification, I start out by estimating the effect of the first deadly tornado in a given county on the Democratic vote share. To provide empirical support for the assumption of parallel trends, I follow Borusyak et al. (2022) and estimate the regression on the set of untreated observations only:

$$Y_{ct} = \alpha_c + \beta_t + \sum_{k=-K}^{-1} \mu^k \mathbb{1}(t - E_c = k) + \varepsilon_{ct} \quad , \tag{4}$$

The event-time coefficient μ^k traces the differential time path of the Democratic two-party vote share in treated relative to untreated counties before and after the first deadly tornado. Specifically, estimates $\mu^k; \tau \geq 0$ represent the average effect of the first deadly tornado on the Democratic two-party vote share in election $k \equiv t - E_c$ after the event. I estimate all event-time indicators and report the coefficients for the five elections before and the four elections after the treatment. Throughout the paper, I report standard errors clustered at the county level.

Parallel trends: One may worry about the plausibility of the parallel trends assumption in my setting. That is, counties belonging to different tornado-prone regions within

[27] I also investigate the average effect on the second, third, and fourth election after the treatment but not as an average across multiple subsequent elections.

a state might be on different voting behavior paths.[28] The proposed approach for pre-trend testing by Borusyak et al. (2022) employed here deviates from the conventional method, in which pre-trend or placebo coefficients are estimated simultaneously with the treatment effect $\hat{\tau}$. The advantages are (i) separating the validation of the design (i.e., of the ex-ante assumption of parallel trends) from the estimation given the design, (ii) improved efficiency of treatment effect estimation as all untreated observations are utilized in the imputation process, and (iii) the removal of the correlation between the treatment effect and the pre-trend estimators. The latter prevents potential bias from following the conventional practice of trusting the results only conditionally on the pre-trend test passing (Roth, 2022). This strategy should assuage concerns about violations of the parallel trends assumption in my setting.

Multiple treatments per unit: Counties may be hit more than once by a deadly tornado over time. Indeed, 613 counties in my dataset experienced a deadly tornado more than once between 1950 and 2020.[29] This poses a potential threat to the causal identification of deadly tornado effects on voting behavior. If each deadly tornado is viewed as a separate event with its own persistent effects it would be impossible to distinguish between the effects of different past deadly tornadoes.

I propose three solutions to mitigate concerns that the estimated effect is biased because of past treatments. First, in my baseline sample, I exclude county-election observations after a second deadly tornado. Hence, I only consider counties which have been treated *for the first time since 1950* (see Section 6.1). As I employ election data from 1960 onward, I leave sufficient time for treatment effects to "cool off" if counties were experiencing a deadly tornado before 1950. Second, and related to the "cooling off" period of treatment effects, I investigate the treatment effect's persistence. I believe it is reasonable to assume that the effects of a negative shock caused by a deadly tornado do not last more than a few years for most people. Third, I also exploit the randomness of the relative timing a deadly tornado has with respect to US gubernatorial elections (see Section 6.2). Effect transitoriness suggests that tornadoes close to elections would have a larger effect on voting behavior.

[28] While there is substantial heterogeneity in the likelihood of deadly tornado experience across counties in the United States, the difference decreases substantially when only comparing counties within the same state (see Figure 1).

[29] See Adda (2016) for a similar setup with multiple treatments per unit.

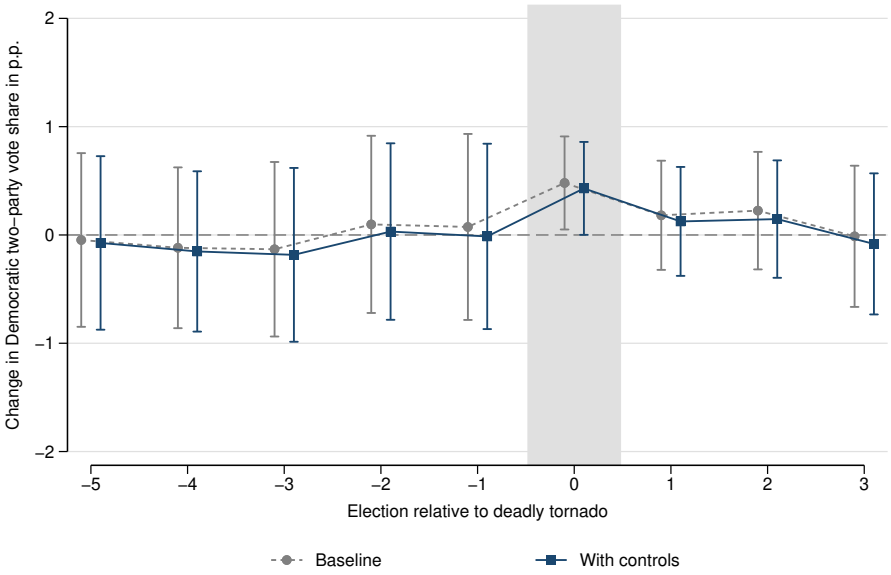
6 Results

In Section 6.1, I report the baseline results for estimating Equation 4 with the sample of counties which have been struck by a deadly tornado *for the first time since 1950*. Never-treated and later-treated counties constitute the comparison group. In Section 6.2, I investigate the influence of varying treatment intensities across deadly tornadoes on voting behavior. Treatment intensity increases with the number of fatalities and with proximity to the election. In Section 6.3, I analyze how voting behavior reacts to deadly tornadoes when allowing for multiple treatments.

6.1 Baseline

My baseline specifications examine the impact of the first deadly tornado since 1950 in a given county on the Democratic vote share in gubernatorial elections. I only include county-election observations up to the point of a second event, that is a second deadly tornado in my observation period. Figure 4 plots the pre-trend estimates obtained from the regression outlined in Equation 4 and "treatment effects" for up to four gubernatorial elections following the deadly tornado, estimated by the imputation method according to Equation 3. Estimates are charted with 95% confidence intervals (CI). The grey dashed line illustrates the development of pre-trend and treatment coefficients with county and election fixed effects. The blue solid line connects coefficients with additional population controls. The figure validates the empirical design: I observe no signs of different pre-trends with the empirical strategy explained in Section 5, as pre-trend coefficients are small and statistically indistinguishable from zero. Hence, the Democratic two-party vote share does not differ systematically between treated counties and the comparison group before the treatment.

Figure 4 Baseline model specifications



Notes: The figure shows the results for my baseline event study design. The grey dashed line illustrates the development of pre-trend and treatment coefficients with county and election fixed effects. The blue solid line connects coefficients with additional population controls. I observe the difference in the Democratic two-party vote share between treated and control counties for five gubernatorial elections before and four gubernatorial elections after a deadly tornado in treated counties. The test for parallel trends includes five pre-treatment periods. Pre-trend and treatment coefficients are shown in Column I and II, Table D.3.

By contrast, the treatment coefficient in period zero is 0.48 (0.43) p.p. and statistically distinguishable from zero at the 95% CI in the baseline (with population controls). Period zero is the first election after the deadly tornado. Hence, voters in counties struck by a deadly tornado are relatively more likely to vote for the Democratic gubernatorial candidate: The vote share for the Democratic candidate is almost half a percentage point higher in treated counties than in the comparison group. Although the effect refers to a single county, a deadly tornado might very well affect state-wide electoral outcomes considering multiple examples of tight races in the US gubernatorial election history (e.g., 1950 Michigan (margin: 0.06%), 1962 Minnesota (0.01%), 1981 New Jersey (0.08%), and 2004 Washington (0.005%)). Further, the increased vote share for the Democratic candidate after a deadly tornado is preliminary evidence for a change in voters' preferred policy, as described in Section 2. I investigate the proposed mechanism in more detail by isolating the change in preferred policy from other potentially confounding channels, such as gubernatorial or party incumbency, in Section 7.

The treatment coefficients suggest that the treatment effect is somewhat persistent. I only observe statistically significant treatment coefficients in the first election following a deadly tornado. The magnitude of the treatment coefficients for the second and third election after the event is around one-third of the treatment effect in period t but statistically indistinguishable from zero at the 95% CI. This suggests that part of the effect may carry over to the second and the third election before vanishing in the fourth election with the coefficient being back to around zero.[30] I report all pre-trend and treatment coefficients along with the corresponding 95% CI in Column I, Table D.3, for my baseline specification. I add a county's total population as a control variable in Column II, Table D.3, because more people in a given county may increase the likelihood of a tornado-prone death while simultaneously being correlated with a higher vote share for Democrats. While county fixed effects are suitable to capture time-invariant characteristics (i.e., a county's size), they fail to pick up dynamic effects. As a county's population changes over time, I control for population developments in the following specifications.

6.2 Treatment intensity

So far, my sample includes all deadly tornadoes regardless of the number of fatalities and the exact timing of the tornado. It is reasonable to assume that deadly tornadoes closer to an election are more likely to impact election results. The change in voters' preferences is stronger because it is less confounded by other experiences. The number of fatalities is a good proxy for the magnitude of a tornado. Casualties are strongly correlated with economic damage (Deryugina and Marx, 2021). The line of argument goes as follows: The more tornado-related casualties, the greater the negative shock and the more likely a change in preferences and, hence, a change in voting behavior.

[30] Bechtel and Hainmueller (2011) investigate short- and long-term electoral effects from the 2002 Elbe flooding in Germany and find a similar pattern.

Deadly tornado less than 12 months before the election: My study design is ideally suited to investigate variable treatment intensity due to the exogenous timing of a deadly tornado. I conduct a subsample analysis including only deadly tornadoes striking within one year before the gubernatorial election (320 treated county-election observations). The treatment coefficient for period t increases by around 75% compared to the baseline specification with controls and is inside the statistical significance of the 95% CI.

Deadly tornado with five or more fatalities: In this subsample analysis, I define the treatment as experiencing five or more tornado-induced fatalities since the last US gubernatorial election (235 treated county-election observations). The treatment coefficient for period t increases to 0.568 p.p, however remains outside any statistical significance at conventional levels.

Deadly tornado with five or more fatalities and less than 12 months before the election: Combining the two treatment intensity measures (timing and fatalities), I estimate a model with 80 treated county-election observations. The treatment coefficient for period t is large (1.673 p.p.) and significant at the 90% CI. The standard error increases further due to the relatively small number of treated county-election observations.

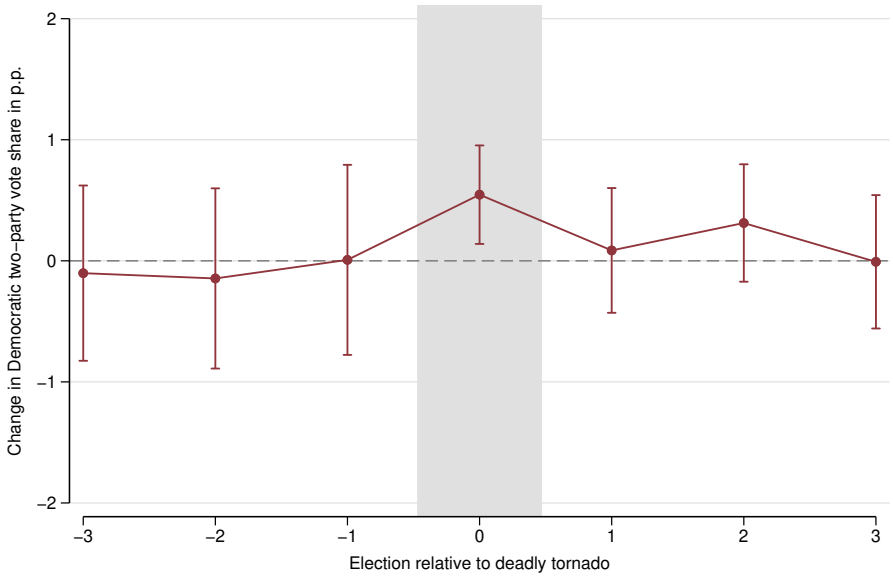
6.3 Multiple treatments

In the previous model specifications, I only included counties experiencing their first deadly tornado since 1950 in the treatment group. This implies that county-election observations after a second treatment were excluded from the sample. To reinforce my argument that deadly tornado experiences shift voters' preferences toward the policy platform offered by Democratic candidates, it would be ideal to demonstrate that multiple treatments in a given county have similar effects. A second deadly tornado should, with some temporal distance from the first, increase the Democratic vote share again. To investigate this empirically, I relax the assumption of spill-over effects from a deadly tornado in the sense that I limit the "cooling off" period between events to four election periods. Assuming that the election at period t is treated – a deadly tornado struck since the last gubernatorial election – then election periods $t+1$, $t+2$, and $t+3$ would be part of the "cooling off" period, in line with treatment coefficients

considered so far in the event study. I, hence, incorporate in my treatment group all deadly tornadoes between 1950 and 2020, which hit a given county without a fatal tornado experience for at least three electoral cycles.

Figure 5 shows the same pattern as previous model specifications: (i) treated counties do not differ in their Democratic two-party vote share from counties in the comparison group before the event, (ii) a deadly tornado causes an increase in the Democratic two-party vote share in the following gubernatorial election, and (iii) evidence suggests that the treatment effect is somewhat persistent but decreases sharply in the next elections. The treatment coefficient in period zero is slightly higher than in the baseline specification with controls and statistically distinguishable from zero at the 99% CI.

Figure 5 Multiple treatments allowed



Notes: The figure shows the results for my event study design allowing for multiple treatments per county. I observe the difference in the Democratic two-party vote share between treated and control counties for three gubernatorial elections before and four gubernatorial elections after a deadly tornado in treated counties. The test for parallel trends includes five pre-treatment periods. However, coefficients for $t-4$ and $t-5$ are not reported because the sample is highly unbalanced in these periods. Pre-trend and treatment coefficients are shown in Column III, Table D.3.

7 Discussion

This section investigates mechanisms to explain the increase in the Democratic vote share in gubernatorial elections after deadly tornadoes. I examine governor and party incumbency effects and discuss the federal disaster response to tornadoes. In Appendix A, I show that the impact of deadly tornadoes on electoral outcomes manifests on the state level rather than on the federal level and provide reasons.

7.1 Incumbency effects

The incumbent's status, performance, and characteristics influence voter behavior after disasters.[31] Depending on this mix and its reception by voters, disasters may have positive, negative, or no effect on the incumbent's vote share.[32] Identifying the exact mechanism through which a disaster influences the incumbent's vote share poses a challenge to researchers. My study setup allows me to analyze the mechanism of how disasters influence voting behavior while ruling out incumbency effects. My proposed channel – a change in voter's preferences – should ideally work independently of incumbency effects.

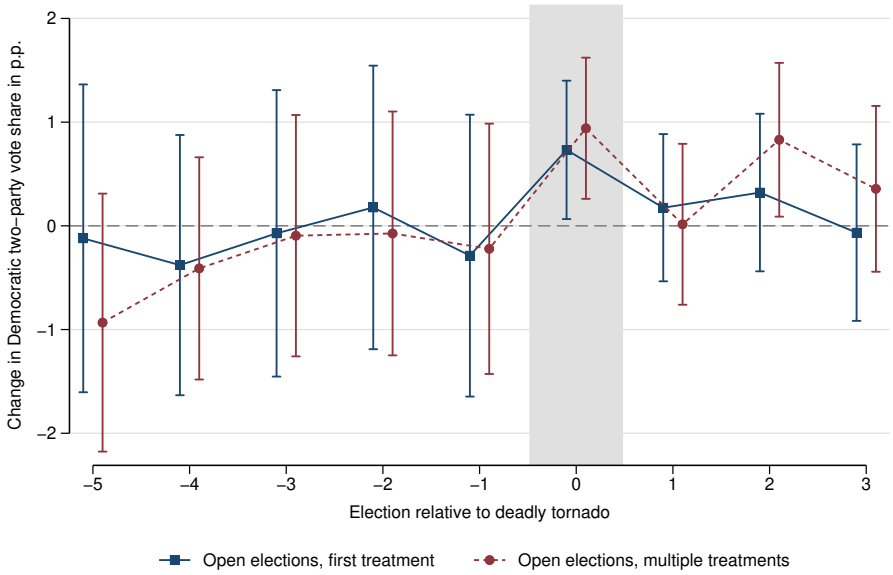
Open seat elections: To rule out that the increase in the Democratic vote share after a deadly tornado is driven by a systematic difference in the incumbent's response along party lines, e.g., the Democratic governor attracts more financial disaster relief, she is more present in the media, she is more empathetic, etc., I only consider open seat elections. Term limits are the most common reason for open seat elections. Others are (personal) decisions by standing governors not to run for reelection despite the judicial ability. Figure 6 confirms my baseline results. Excluding governor incumbency effects do not change inferences. I still observe no signs of different pre-trends in voting behavior for treated counties and the comparison group. The treatment coefficient in period zero is 0.733 p.p. and inside the statistical significance of the 95% CI. In the

[31] Irrational retrospective voting: Wolfers et al. (2002); Achen and Bartels (2002, 2016); Leigh (2009); Healy and Malhotra (2010); disaster relief effort: Healy et al. (2010); Bechtel and Hainmueller (2011); Gasper and Reeves (2011); Cole et al. (2012); Neugart and Rode (2021); Cooperman (2022); new information: Ashworth et al. (2018); Cerqua et al. (2021); Masiero and Santarossa (2021).

[32] (+): Bechtel and Hainmueller (2011); Chen (2013); Masiero and Santarossa (2021); Neugart and Rode (2021); (−): Wolfers et al. (2002); Achen and Bartels (2002, 2016); Leigh (2009); Healy et al. (2010); Gasper and Reeves (2011); Cole et al. (2012); Heersink et al. (2017); (∼): Abney and Hill (1966); Ebeid and Rodden (2006); Kayser and Peress (2012).

model specification allowing for multiple treatments, the coefficient increases to almost one p.p. and is statistically significant at the 1% level. Standard errors of pre-trend and treatment coefficients are larger because of the smaller sample size.

Figure 6 Open seat elections



Notes: The figure shows the results for my baseline event study design including controls (blue squares) and allowing for multiple treatments (red dots) for elections with Democratic party incumbency in period t. I observe the difference in the Democratic two-party vote share between treated and control counties for five gubernatorial elections before and four gubernatorial elections after a deadly tornado in treated counties. The test for parallel trends includes five pre-treatment periods. Pre-trend and treatment coefficients for the baseline specification with controls are reported in Column I, Table D.4.

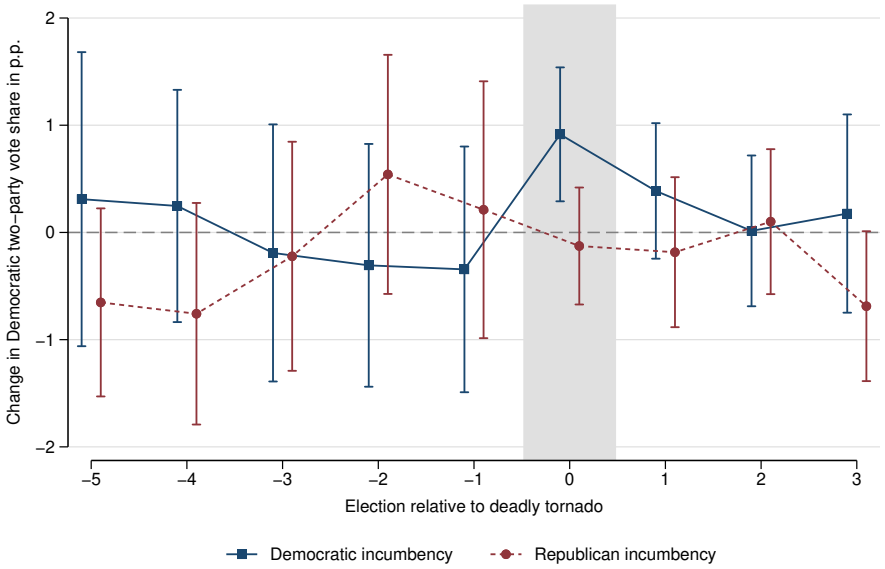
Controlling for party incumbency: While open seat elections rule out governor incumbency effects, they do not account for potential party incumbency effects. It is possible that the Democratic candidate in the next election gets credit (or punished) for the Democratic governor's disaster response. The Democratic governor herself does not stand for reelection but her party does. The succeeding candidate may have previously served in the governor's cabinet, actively contributing to the state's executive disaster response. Splitting the sample in elections with Democratic and Republican governor incumbency yields dissimilar results.

Figure 7 illustrates the results for counties being treated when a Democratic governor was in power (blue) and Republican governor incumbency (red). In Panel A, I only include counties experiencing their first deadly tornado since 1950 in the treatment

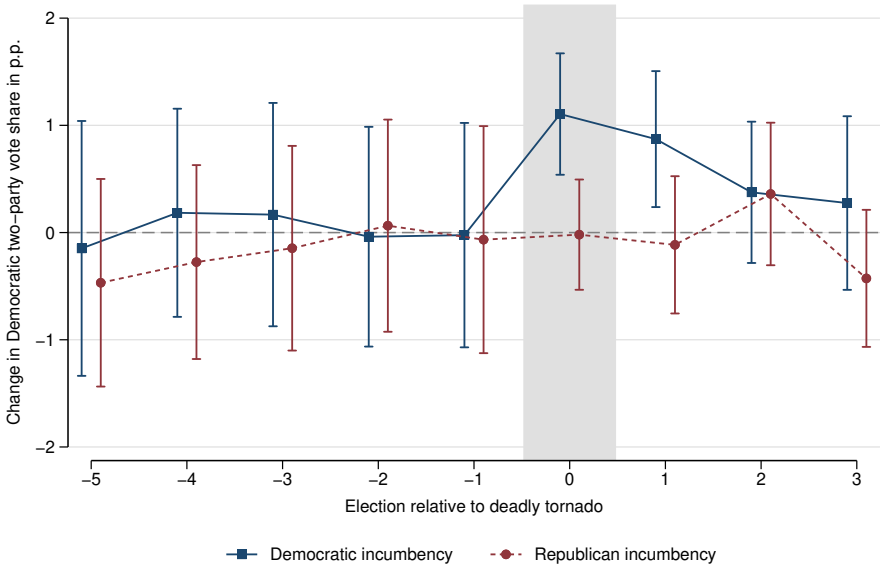
group. Panel B shows results for the model specification with multiple treatments. Under Democratic incumbency, the treatment effect in t – the election following the deadly tornado – is about twice as large compared to the baseline and statistically significant at the 1% level (1,066 treated county-election observations). Vice versa, the treatment coefficient for the sample with Republican incumbency only (897 treated county-election observations) is slightly negative and statistically indistinguishable from zero at conventional levels. This implies that voters in counties experiencing a deadly tornado under a Democratic governor are more likely to vote for the Democratic candidate in the next gubernatorial election whereas voters in treated counties controlled by a Republican governor do not vote differently compared to the comparison group.

The evidence suggests two mechanisms that either work in conjunction with or against each other. The party incumbency mechanism indicates that, on average, the candidate of the incumbent party benefits from the governor's disaster response in the subsequent election. The mechanism's strength is about the same magnitude as the identified effect of a shift in voters' preferences toward the policy platform offered by Democratic candidates and the resulting increase in the Democratic vote share. No aggregate treatment effect can be observed when examining treated counties in Republican-controlled states. Treated counties in states governed by a Democrat vote about one p.p. more for the Democratic candidate in the following gubernatorial election compared to counties in the comparison group. About half of the increase can be attributed to either mechanism: party incumbency and a shift in the voter's preferred policy.

Figure 7 Party incumbency



(a) First treatment



(b) Multiple treatments

Notes: The figure shows the results for Democratic governor incumbency (blue squares) and Republican governor incumbency (red dots) for first treatments (Panel A) and multiple treatments (Panel B). I observe the difference in the Democratic two-party vote share between treated and control counties for five gubernatorial elections before and four gubernatorial elections after a deadly tornado in treated counties. The test for parallel trends includes five pre-treatment periods. Pre-trend and treatment coefficients from Panel A are shown in Columns II and III, Table D.4.

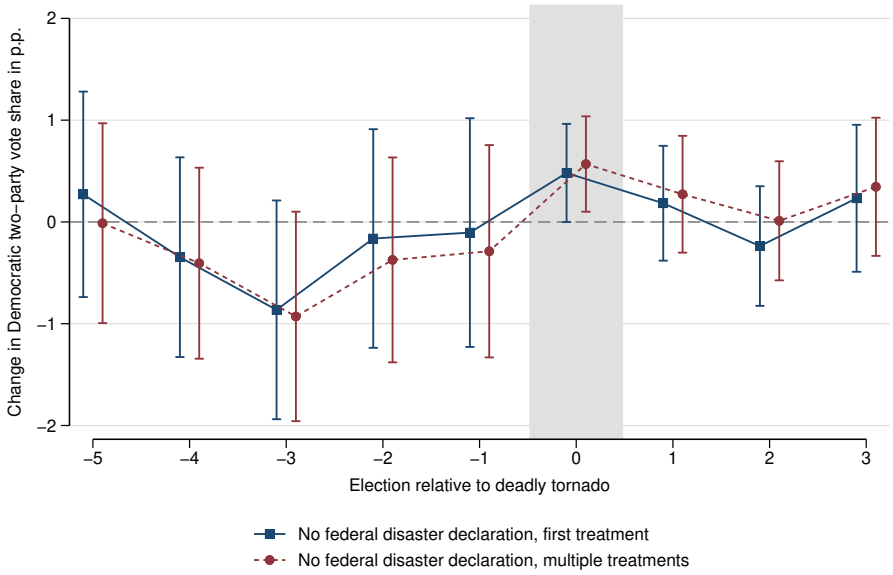
7.2 Federal disaster response

A remaining threat to interpreting the results as a shift in voters' preferences toward the policy platform offered by Democratic candidates is the potentially confounding impact of the federal disaster response. Democratic governors may simply be better at attracting federal disaster relief money and therefore get rewarded at the polls in affected counties. A growing economic literature investigates discretionary mechanisms in the allocation of funds (e.g., Brollo and Nannicini, 2012; Hodler and Raschky, 2014; Burgess et al., 2015; Chu et al., 2021). Schneider and Kunze (2023) document a heterogeneous political bias in presidential disaster declarations in the United States: Counties governed by president's co-partisans receive more relief money after medium-intensity hurricane winds. Disaster declaration decisions are a unilateral power of the US president. She decides which counties are covered by a declaration (Gasper and Reeves, 2011). I exclude the possibility of federal funds flowing into tornado-affected counties by only considering deadly tornadoes with no presidential disaster declaration in the aftermath.

FEMA (2023) provides data on all official FEMA Disaster Declarations, beginning with the first declaration in 1953. The data includes all federally declared disasters and recovery programs on the state and county-level.[33] I use the incident type and the declaration title to identify declarations due to tornadoes. Furthermore, I match the data with the tornado data using the incident begin and end dates along with the counties covered by the declaration. Figure 8 shows the event study estimates excluding counties which were eligible for federal disaster relief after a deadly tornado. The treatment coefficient in period t is similar in size to the baseline specification with first treated county-election observations. The coefficient just misses statistical significance at the 5% level, but becomes larger and significant when considering all treated county-election observations. Although pre-trend coefficients are more volatile due to the limited sample size, treated counties and the comparison group do not vote systematically differently before the event. Therefore, my inferences hold when excluding the possibility of disaster relief efforts from the federal level.

[33] Data on the county-level is available from 1964 onward.

Figure 8 Excluding disaster declarations



Notes: The figure shows the results for my baseline event study design including controls (blue squares) and allowing for multiple treatments (red dots) for deadly tornadoes without a federal disaster declaration. I observe the difference in the Democratic two-party vote share between treated and control counties for five gubernatorial elections before and four gubernatorial elections after a deadly tornado in treated counties. The test for parallel trends includes five pre-treatment periods. Pre-trend and treatment coefficients are reported in Columns I & II, Table D.5.

8 Conclusion

In this paper, I build on a spatial model of voting with valence and a rich empirical literature on natural disasters, risk aversion, and electoral outcomes to understand how deadly tornadoes influence US gubernatorial elections. My framework predicts that the voter's preferred policy moves closer toward the policy platform offered by the Democratic candidate after a deadly tornado. Voters demand more social insurance, something Democrats promise and Republicans oppose.

My main analysis describes a causal effect of deadly tornadoes on the rise of the Democratic two-party vote share in US gubernatorial elections from 1960 to 2020. The Democratic candidate's vote share increases by almost half a percentage point in affected counties. I confirm this result by investigating open seat elections to rule out a governor incumbency effect. To further supplement my analysis, I examine evidence for the underlying mechanism explaining the rising fortune of Democratic candidates after a deadly tornado. Deadly tornadoes do not seem to influence voting behavior when a

Republican governor is in power. Under a Democratic governor, the effect size is about twice as large as in the baseline specification. The results suggest that two mechanisms work either in conjunction or against each other. In line with the literature identifying a positive incumbency effect, I find that the candidate of the incumbent party benefits from the governor's disaster response in the subsequent election (e.g., Bechtel and Hainmueller, 2011; Chen, 2013; Neugart and Rode, 2021). As proposed by my spatial model of voting with valence, I also observe a shift in voters' preferences toward the policy platform offered by Democratic candidates and the resulting increase in the Democratic vote share. My evidence suggests that the strength of the two mechanisms is about equal in magnitude.

A challenge in empirical studies examining the channel through which a negative shock influences voter behavior is eliminating alternative explanations. My setup allows me to connect a deadly tornado to an increased Democratic vote share via a change in voters' preferred policies. The finding that Democrats benefit from deadly tornadoes partly contradicts existing research documenting a positive relationship between crisis experience and voter preference for leadership and conservatism (e.g., Stenner, 2005; Merolla and Zechmeister, 2009; Holman et al., 2016, 2019, however in the context of terrorism). It accommodates the finding of Pastor and Veronesi (2020), who show that Democratic voters are more risk averse. Their model of political cycles predicts that more risk averse agents elect Democrats because they promise more social security and redistribution. Future research might explore the extent to which risk aversion increases after a deadly tornado. Ideally, future research would also investigate county heterogeneity in voter motivation in US gubernatorial elections. Finally, studies exploring different contexts could discuss my finding that a crisis experience alters a voter's preferred policy.

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A Presidential elections

A natural addition to my study is to examine electoral outcomes on different levels of government. Studying the impact of deadly tornadoes on electoral outcomes of local government is intriguing, however, not feasible with my event study design due to the absence of a suitable comparison group. Turning to the federal level, county-level data availability of electoral outcomes is best for presidential elections. The US president as head of the executive has far-reaching powers such as commanding the armed forces, vetoing legislation passed by congress, conducting foreign relations (negotiating treaties and international agreements), and appointing federal judges, ambassadors, executive branch officials, and the like. She also plays a decisive role in disaster relief efforts when state capacities are exhausted. The excursion into county-level presidential election outcomes follows three steps. First, I focus on voters' motivation in presidential elections. Second, I present results on how deadly tornadoes affected voter behavior in presidential elections. Third, I discuss the results pointing out similarities and differences to findings in gubernatorial elections.

> *"It's the economy, stupid"*
> — James Carville, 1992

The phrase, coined in Bill Clinton's 1992 presidential campaign, soon became representative of the political ramifications resulting from the economic conditions during presidential elections. Politicians and analysts have long acknowledged the decisive role of the economy in making presidents. Past incumbent defeats, such as Herbert Hoover's and Jimmy Carter's, can be attributed to economic crises. Clinton's team used the quip successfully to unseat George H W Bush, despite the incumbent's overwhelming job approval by US voters just one and a half years earlier (89%).[34] In addition to the economy as arguably the most important factor in determining presidential election outcomes (*"economic voting"*) (e.g., Erikson, 1989; Lewis-Beck and Stegmaier, 2000; Zaller, 2004; Healy and Lenz, 2017; Lewis-Beck and Martini, 2020), the second influential topic voters base their electoral decision on is foreign policy (e.g., Aldrich et al., 1989, 2006; Page and Shapiro, 2010; Johnstone and Priest, 2017) and the

[34] A job approval rating of 89% has been the highest for any sitting US president since Gallup started recording data in the 1940s. The mark was surpassed by one p.p. when his son George W Bush proclaimed the war on terror after 9/11 (Gallup, 2001).

link between the two through, for instance, international trade (Jensen et al., 2017). Nickelsburg and Norpoth (2000) wrote "to maintain public support the chief executive must be 'commander-in-chief' and 'chief economist' in equal measure" (p. 313). The *Financial Times*, referring to Carville's phrase, stated in February 2022 regarding the next electoral cycle: "It's geopolitics, stupid".

Comparably little is known about the influence of social welfare policies on US presidential election outcomes. The salience of issues owned by either the Democrats or the Republicans is correlated with voter turnout for the respective party (Petrocik et al., 2003). Studies examining individual US presidential elections show a positive correlation between health insurance coverage and the vote share for the Democratic presidential candidate (Hollingsworth et al., 2019). However, they do not find a causal link between social insurance issues and the presidential vote (Alvarez and Nagler, 1998).

Multiple layers of government design, fund, and administer social insurance programs which leads to voters being typically not aware of the program's exact origins and responsibilities. The federal government funds large programs, such as Social Security and Medicare, and manages tax credits under the umbrella of the social insurance system (e.g., Earned Income Tax Credit and Child Tax Credit). Most programs, however, are jointly funded by the federal and state government and administered by states. States possess substantial discretionary power to influence eligibility criteria which results in considerable variability in coverage rates across states. In the example of Medicaid, some states have adopted comprehensive insurance schemes covering many optional health services, while 11 states have not even adopted the expansion under the Affordable Care Act. The relatively low priority of social welfare policies in US presidential elections, along with the involvement of different layers of government in social insurance programs, suggests that voters might not express their change of preferences for more social protection after a deadly tornado in US presidential elections. Voters may only express their increased demand for social protection in state elections.

So far, we have observed significant changes in electoral behavior after a deadly tornado in US gubernatorial elections. To investigate whether the shift in voters' preferences toward the policy platform offered by Democratic candidates also materializes in an increased Democratic vote share on the federal level, I run my event study model with data on US presidential election outcomes on the county level. Pre-trend

coefficients are negative and sometimes statistically significant at conventional levels, implying that treated counties vote, on average, more Republican in presidential elections (see Column I, Table D.5). In the first election after the deadly tornado, the coefficient is still negative but elevated compared to the pre-trend coefficients, suggesting relatively more votes for the Democratic candidate. However, the coefficient is indistinguishable from zero at conventional levels. When increasing the treatment intensity by including only counties experiencing a deadly tornado with five or more fatalities less than 12 months before the presidential election in the treatment group, the coefficient for the change in the Democratic two-party vote share turns positive in the election after the treatment (see Column II, Table D.5). Due to the limited number of observations, standard errors are large and treatment coefficients are not statistically significant. Pre-trend coefficients are negative and similar to the previous model specification.

Taken together, the average Democratic two-party vote share in presidential elections is higher in counties experiencing a deadly tornado. However, the evidence is not strong enough to draw a causal link between a deadly tornado and an increase in the vote share for the Democratic presidential candidate. Voter motivation differs between the federal and the state level which leads to diverging voter behavior. Voters' response to local shocks materializes to different degrees across levels of government. Local events do normally not play a decisive role in voters' decision-making on the federal level.

B Supplementary tables

Table D.1 Sample means of control and treatment group and t-tests for differences in mean Democratic two-party vote shares

(I) **Variable**	(II) **Control (mean)**	(III) **Treatment (mean)**	(IV) **Difference (t)**
	Panel A: Multiple treatments allowed		
Democratic two-party vote share (%)	48.786	50.579	1.793 (4.775)
	Panel B: Only first treatments (since 1950)		
Democratic two-party vote share (%)	49.180	52.071	2.891 (5.705)

Notes: The table reports the mean levels of the Democratic two-party vote share of counties included in my sample for the control group (Column II) and the treatment group (Column III). The differences between the means are reported in Column IV, with test statistics of a two-sample t-test reported in parentheses. In Panel A, the control group is defined as counties which did not experience a deadly tornado since the last gubernatorial election. The treatment group is defined as counties which experienced a deadly tornado since the last gubernatorial election. The control group in Panel B includes counties which did not experience a deadly tornado from 1950 to the election before the deadly tornado and counties which did not experience a deadly tornado in the whole sample period (1950–2020). The treatment group in Panel B only includes counties which experienced a deadly tornado since the last gubernatorial election with that tornado being the first lethal one since 1950.

Table D.2 Frequency of deadly tornadoes across counties, 1950–2020

(I) **Deadly tornado (count)**	(II) **Frequency**	(III) **Percent**	(IV) **Cumulative**
1	776	55.87	55.87
2	354	25.49	81.35
3	141	10.15	91.50
4	59	4.25	95.75
5	28	2.02	97.77
6	17	1.22	98.99
7	6	0.43	99.42
8	3	0.22	99.64
9	3	0.22	99.86
10	1	0.07	99.93
11	1	0.07	100.00

Notes: The table reports the frequency of deadly tornadoes for counties struck at least once by a deadly tornado between 1950 and 2020. A total of 1,389 counties experienced at least one deadly tornado between 1950 and 2020. Source: National Oceanic and Atmospheric Administration (2022).

Table D.3 Baseline event study results and multiple treatments

	(I)	(II)	(III)
Deadly tornado (t - 5)	-0.046	-0.074	–
	[-0.848; 0.756]	[-0.875; 0.727]	
Deadly tornado (t - 4)	-0.118	-0.152	–
	[-0.861; 0.624]	[-0.893; 0.588]	
Deadly tornado (t - 3)	-0.132	-0.184	-0.102
	[-0.938; 0.674]	[-0.986; 0.619]	[-0.826; 0.622]
Deadly tornado (t - 2)	0.098	0.031	-0.146
	[-0.720; 0.916]	[-0.784; 0.846]	[-0.890; 0.599]
Deadly tornado (t - 1)	0.074	-0.013	0.008
	[-0.785; 0.933]	[-0.869; 0.842]	[-0.777; 0.793]
Deadly tornado (t)	0.480**	0.430**	0.546***
	[0.051; 0.910]	[0.001; 0.859]	[0.140; 0.953]
Deadly tornado (t + 1)	0.182	0.125	0.086
	[-0.322; 0.686]	[-0.378; 0.628]	[-0.429; 0.601]
Deadly tornado (t + 2)	0.225	0.146	0.312
	[-0.318; 0.767]	[-0.396; 0.689]	[-0.172; 0.797]
Deadly tornado (t + 3)	-0.013	-0.083	-0.008
	[-0.664; 0.639]	[-0.734; 0.569]	[-0.559; 0.543]
Observation	37,220	37,220	41,491
County FE	✓	✓	✓
Election FE	✓	✓	✓
First treatment	✓	✓	
Controls		✓	✓
Multiple treatments			✓

Notes: The table reports event study coefficients based on Equation 3 and 4 with the 95% confidence interval in brackets. The dependent variable is the Democratic two-party vote share (in %) in US gubernatorial elections. Column I reports coefficients for the baseline specification with county and election fixed effects. Column II reports coefficients for the baseline specification with county and election fixed effects and population controls. Column III reports coefficients for the model specification with county and election fixed effects and population controls allowing for multiple treatments.

*** Significant at the 1% level,
** Significant at the 5% level

Table D.4 Event study results to investigate incumbency effects

	(I)	(II)	(III)
Deadly tornado (t - 5)	-0.120	0.310	-0.653
	[-1.604; 1.364]	[-1.061; 1.682]	[-1.530; 0.224]
Deadly tornado (t - 4)	-0.379	0.247	-0.758
	[-1.633; 0.876]	[-0.836; 1.330]	[-1.792; 0.275]
Deadly tornado (t - 3)	-0.072	-0.191	-0.222
	[-1.454; 1.309]	[-1.390; 1.008]	[-1.291; 0.846]
Deadly tornado (t - 2)	0.177	-0.307	0.541
	[-1.190; 1.544]	[-1.439; 0.825]	[-0.574; 1.656]
Deadly tornado (t - 1)	-0.287	-0.345	0.212
	[-1.646; 1.071]	[-1.491; 0.801]	[-0.986; 1.410]
Deadly tornado (t)	0.733**	0.915***	-0.127
	[0.065; 1.400]	[0.290; 1.539]	[-0.672; 0.419]
Deadly tornado (t + 1)	0.175	0.387	-0.184
	[-0.535; 0.885]	[-0.245; 1.019]	[-0.884; 0.515]
Deadly tornado (t + 2)	0.321	0.015	0.101
	[-0.439; 1.081]	[-0.689; 0.718]	[-0.575; 0.777]
Deadly tornado (t + 3)	-0.065	0.176	-0.688
	[-0.916; 0.785]	[-0.749; 1.101]	[-1.387; 0.011]
Observation	35,434	35,672	35,309
County FE	✓	✓	✓
Election FE	✓	✓	✓
Controls	✓	✓	✓
First treatment	✓	✓	✓
Open seat only	✓		
Democratic incumbency		✓	
Republican incumbency			✓

Notes: The table reports event study coefficients based on Equation 3 and 4 with the 95% confidence interval in brackets. The dependent variable is the Democratic two-party vote share (in %) in US gubernatorial elections. Column I reports coefficients for the baseline specification with county and election fixed effects and population controls for open seat elections in period t. Column II reports coefficients for the baseline specification with county and election fixed effects and population controls for elections with Democratic party incumbency in period t. Column III reports coefficients for the baseline specification with county and election fixed effects and population controls for elections with Republican party incumbency in period t.

*** Significant at the 1% level,
** Significant at the 5% level

Table D.5 Event study results to investigate the impact of federal disaster relief and presidential election outcomes

	(I)	(II)	(III)	(IV)
Deadly tornado (t - 5)	0.271	-0.013	-0.583*	-0.583*
	[-0.738; 1.281]	[-0.994; 0.969]	[-1.180; 0.013]	[-1.180; 0.013]
Deadly tornado (t - 4)	-0.346	-0.406	-0.478	-0.502
	[-1.327; 0.635]	[-1.344; 0.533]	[-1.133; 0.176]	[-1.157; 0.153]
Deadly tornado (t - 3)	-0.863	-0.928*	-0.734**	-0.722**
	[-1.938; 0.211]	[-1.957; 0.101]	[-1.440; -0.029]	[-1.430; -0.013]
Deadly tornado (t - 2)	-0.163	-0.373	-0.914**	-0.915**
	[-1.237; 0.911]	[-1.379; 0.634]	[-1.652; -0.177]	[-1.658; -0.172]
Deadly tornado (t - 1)	-0.105	-0.288	-0.718*	-0.739*
	[-1.228; 1.019]	[-1.331; 0.755]	[-1.511; 0.075]	[-1.539; 0.061]
Deadly tornado (t)	0.481*	0.569**	-0.165	0.265
	[-0.001; 0.963]	[0.101; 1.037]	[-0.543; 0.214]	[-1.096; 1.626]
Deadly tornado (t + 1)	0.184	0.272	0.131	-0.606
	[-0.380; 0.748]	[-0.302; 0.846]	[-0.310; 0.572]	[-1.907; 0.695]
Deadly tornado (t + 2)	-0.237	0.011	-0.065	-0.512
	[-0.825; 0.351]	[-0.574; 0.596]	[-0.592; 0.463]	[-1.900; 0.876]
Deadly tornado (t + 3)	0.232	0.345	0.077	0.216
	[-0.490; 0.954]	[-0.333; 1.024]	[-0.493; 0.647]	[-0.855; 1.287]
Observation	35,672	38,968	42,112	36,861
County FE	✓	✓	✓	✓
Election FE	✓	✓	✓	✓
Controls	✓	✓	✓	✓
First treatment	✓			
Multiple treatments		✓	✓	✓
No federal disaster relief	✓	✓		
Gubernatorial elections	✓	✓		
Presidential elections			✓	✓
Intense treatment				✓

Notes: The table reports event study coefficients based on Equation 3 and 4 with the 95% confidence interval in brackets. The dependent variable is the Democratic two-party vote share (in %) in US gubernatorial elections (Columns I & II) and in US presidential elections (Columns III & IV). Column I reports coefficients for the baseline specification with county and election fixed effects and population controls for deadly tornadoes without a federal disaster declaration. Column II reports coefficients for the model specification with county and election fixed effects and population controls for deadly tornadoes without a federal disaster declaration allowing for multiple treatments. Column III reports coefficients for the model specification with county and election fixed effects and population controls for US presidential elections allowing for multiple treatments (multiple treatments allowed). Column IV reports coefficients for the model specification with county and election fixed effects and population controls for US presidential elections when the deadly tornado strikes less than 12 months before the election and causes five or more fatalities (multiple treatments allowed).

** Significant at the 5% level,

* Significant at the 10% level