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Swingin' in the Rain: The Impact of Inclement Weather on Voting Behavior in U.S. Presidential Elections

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Swingin' in the Rain:

The Impact of Inclement Weather on Voting Behavior in U.S. Presidential Elections

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Abstract

While political experts have long claimed that bad weather lowers voter turnout, the impact of weather on U.S. election outcomes remains unclear. The most rigorous work to date found that precipitation benefits Republicans and suggested that Florida rains influenced the outcome of the 2000 presidential election, but a more recent analysis finding that precipitation only lowers turnout in uncompetitive election states calls this claim into question. Here, we reanalyze the 1972-2000 U.S. presidential elections with a focus on supporters of non-major party candidates, an oft-overlooked contingency. We propose that bad weather affects election outcomes not through its effect on turnout—as has long been assumed—but rather, through its psychological effect on swing voters. Specifically, we find evidence that bad weather increases regret aversion among supporters of non-major party candidates in competitive elections, leading some to instead vote for their preferred two-party candidate.

Introduction

Since at least the 1800s, the press has claimed that weather affects voter turnout (1). While this popular belief made its way into the political science literature as early as the 1960s when "the fisherman who expects to return from the sea before the polls close but is held up by a storm" was cited as one of many plausible reasons why inclement weather might suppress voter turnout (2), only in recent years have researchers been able to analyze the impact of weather on election outcomes with rigorous empirical methods. Most notably, Gomez, Hansford and Krause (3) utilized meteorological data from over 22,000 U.S. weather stations and, using GIS interpolations, produced estimates of Election Day rain and snow for more than 3,000 U.S.

counties for 14 presidential elections. Through linking this novel dataset with voting data from Congressional Quarterly and other sources, the authors found that Republican vote share increases with precipitation, leading them to conclude, "Republicans should pray for rain." In fact, the 2000 election was so close that their model predicted that the Democratic candidate, Al Gore, would have won if it had rained less in Florida on that Election Day. However, recently this result has been called into question because the model assumed that voter turnout was equally affected by rain in competitive and uncompetitive states. Specifically, Fraga and Hersh (4) found that while rain leads to lower voter turnout *on average*, it does not lead to lower turnout in competitive election states. Therefore, they conclude that rain does not substantively impact election outcomes.

Does Rain Change Voters' Costs or Minds?

In this paper, we propose a different theory of the impact of weather on election outcomes by considering the potential psychological effects of weather on voting behavior. To understand, consider the classic "calculus of voting" model, R = PB - C + D, first proposed by Downs (5) and later adapted by Riker and Ordeshook (6), where R is the reward gained from voting in a given election, P is the probability of a vote influencing the outcome of the election, B is the differential benefit of one candidate winning over the other, C is the cost of voting (e.g., time and effort spent), and D is the psychological benefit of voting derived from things like feelings of civic duty or altruism. Most scholarship on voting has assumed—either explicitly or implicitly—that inclement weather impacts elections only through increasing C, the actual costs associated with voting (e.g., through causing poor driving conditions), and therefore that inclement weather might only impact election outcomes through its effect on voter turnout. In contrast, we argue that inclement weather also impacts voting behavior through its effect on D, the psychology of the voter, and through the individual's perception of the values of P and B. Therefore, we propose that precipitation might impact not only voter turnout, but also voters' choices at the polls.

While our theory may seem extraordinary to some political scientists, a broad psychological literature shows that mood can significantly alter memory (7), social judgments (8), and decision making (9), which suggests that exogenous factors such as weather will affect political behavior through their effect on mood. Pleasant weather (e.g., sunlight, low humidity, and high barometric pressure) is associated with higher subjective well-being, better memory, broadened cognitive style, and overall better mood (10–13), which is associated with optimism bias and risk-seeking behavior (14, 15). In contrast, bad weather is associated with negative mood (16), which is associated with pessimism and risk aversion (17). And, indeed, the effect of weather on mood has been shown to have significant real world outcomes, affecting everything from consumer reviews of restaurants (18) to stock market returns (19).

In the context of political behavior, recent scholarship finds that irrelevant events—for instance, the outcome of local college football games—significantly alter the decisions that voters make on Election Day (20). With regard to the effect of weather, Cohen (21) finds that sunshine leads to higher approval ratings of the president and Bassi (22) finds in a laboratory experiment that bad weather depresses mood and risk tolerance, increasing the likelihood that voters desire candidates who are perceived to be less risky. Building on this work, we propose that inclement weather impacts voting behavior through its effect on risk attitudes. More specifically, we claim that bad weather increases "regret aversion" in competitive election contexts, which motivates some voters to behave as though their vote—or lack thereof—might actually influence the election's outcome. Notably, our theory is consistent with Fraga and

Hersh's (4) finding that precipitation does not lead to lower turnout in competitive election states. That is, while precipitation indeed increases the cost of voting, this cost is counterbalanced by the fact that voters are more fearful that their least preferred candidate will win the election. However, we deviate significantly from previous models of the impact of weather on voting outcomes by explicitly considering supporters of non-major party candidates, an oft overlooked contingency.

Supporters of non-major party candidates know that their preferred candidate will not win regardless of their individual vote, so one might think that the competitiveness of the election should have little effect on turnout for non-major party candidates. However, while the chances of a non-major party candidate winning remain negligible in competitive election states, people who vote for these candidates in competitive election states risk increasing the chances that their preferred major-party candidate will lose. Indeed, non-major party candidates are frequently accused of "spoiling" elections for the major-party candidate to which they are closest ideologically, most famously in the 2000 presidential election when Green Party candidate, Ralph Nader, received a non-trivial share of the vote in several swing states, including in Florida. Of course it was in Florida where George W. Bush won by approximately 0.01% of the vote, securing a majority of the Electoral College for the Republicans. Exit polls suggested that more Nader voters would have voted Democrat than Republican had Nader not been on the ticket, and undoubtedly some of these voters were relatively indifferent about their final decision (23). In these circumstances and for these individuals, the impact of inclement weather on mood may have been decisive. More precisely, we theorize that inclement weather in competitive election contexts increases regret aversion among supporters of non-major party candidates, leading some to instead vote in favor of their preferred major-party candidate.

Overview of Hypotheses

To test our theory, we propose two main hypotheses. First, we hypothesize that precipitation leads to decreased turnout for non-major party candidates and that this effect is larger in competitive election states than in uncompetitive election states. This hypothesis is based on the assumption that if precipitation has no effect on voters' *choices* at the polls, then we should expect changes in turnout for non-major party candidates associated with precipitation to be similar in uncompetitive and competitive election states. That is, even if the competitiveness of an election affects the baseline turnout for non-major party candidates, it should not affect the change in turnout as a function of precipitation unless precipitation motivates some supporters of non-major party candidates to instead vote for their preferred major-party candidate.

Second, we hypothesize that precipitation in competitive election states leads to *increased* turnout for the major party candidate that is closest ideologically to the leading non-major party candidate. While it is possible that there are differences between supporters of non-major party candidates in competitive vs. uncompetitive election states that could account for a stronger effect of precipitation on turnout in competitive election states (i.e., hypothesis 1), it is difficult to explain how precipitation could lead to increased turnout for any party unless rain effects voters' choices at the polls. However, if it is true that precipitation decreases turnout for non-major party candidates in competitive elections, then—since Fraga and Hersh (4) found that precipitation does not lead to lower overall turnout in competitive elections—it follows that precipitation must lead to increased turnout in competitive elections for at least one major party candidate. A look at the most significant non-major party candidates over the period we analyze helps to clarify this hypothesis further: Ross Perot in 1992 and 1996, Ron Paul in 1988, and John Anderson in 1980. Many of these candidates received at least 5% of the popular vote and all had strong conservative credentials, cannibalizing the Republican turnout. Thus, we hypothesize that, on average, precipitation leads to increased turnout for the Republican candidate. However, since the progressive Ralph Nader was the most significant non-major party candidate in 2000, precipitation-induced regret aversion among non-major party supporters should have been acting to increase Democratic support that year. Thus, we expect the opposite trend when analyzing the effect of precipitation on turnout in the 2000 presidential election.

Materials and Methods

We follow in the tradition of Gomez et al. (3) and Fraga and Hersh (4). Both research efforts evaluated the effect of precipitation on county-level voter turnout in U.S. presidential elections by utilizing a novel dataset created by Gomez et al. (3), who painstakingly matched meteorological data from over 22,000 U.S. weather stations to the more than 3,000 U.S. county voting results for every election from 1948 to 2000. They accomplished this by first dividing the country into micro cells of 4,000 m^2 (less than an acre), then estimating the rainfall and snowfall in each micro cell with data from nearby weather stations and, finally, determining county-level estimates of rainfall and snowfall from those micro cell totals. The data also includes a set of control variables in order to reduce election-specific variation in turnout unrelated to weather, including county-level measures of average income, percent high school graduates, percent black, number of farms per capita, a measure of how far ahead of Election Day citizens are required to register, a measure of whether a state has a motor-voter law in each year, dummy variables for whether gubernatorial or senatorial races are on the ballot, and the turnout level in the previous presidential election.

While Gomez et al. (3) used this dataset to analyze the impact of precipitation on Republican vote share without considering the competitiveness of elections, Fraga and Hersh (4) added measures of a state's electoral competitiveness to this dataset but only examined the effect of precipitation on average voter turnout. Here, we combine this dataset with party-level turnout data (i.e., as opposed to aggregate turnout totals) from Congressional Quarterly in order to separately model the turnout for Republican, Democratic, and "other" candidates while also taking into account the competitiveness of elections. We also differ from the two earlier studies in our narrowing of the data to only consider the U.S. presidential elections from 1972 to 2000, instead of from 1948 to 2000. While our findings are consistent if we analyze the data beginning in 1948, we—like many other researchers (e.g., 24, 25)—restrict the elections we analyze to those since the ideological switch between the Republicans and Democrats during the Civil Rights Era in order to more representatively model the modern election landscape. On all other data processing decisions, we stipulate to the techniques described in Fraga and Hersh (4).

We also closely follow the analytical approach of Fraga and Hersh (4) by using a least-squares mixed-effects approach to generate estimates from the dataset and we include random effects for each county and fixed effects for each election year in order to account for systematic between-county and between-election variation. We also follow their method of applying Coarsened Exact Matching to ensure that the treatment group (rained) and control group (did not rain) are balanced on the average amount of rain in a county. Furthermore, like Fraga and Hersh (4) but unlike Gomez et al. (3), we use the number of inches of rain or snow for the county as the primary weather indicator and include average rainfall and snowfall as a control variable in order to account for any bias present in particularly rainy or snowy regions. This has the benefit of added clarity given the large fraction of counties that experience no rain on Election Day while not substantively changing the results. Finally, with the exception of the poll tax literacy test, and property requirement dummy variables (which we exclude because there is no variation in these parameters over our period of interest), we also follow the remainder of the covariates and methods used for Model 3 in Fraga and Hersh (4), which utilizes an *ex post* measurement of the state's competitiveness based on the actual margin of victory ranging from 0 (100% of the vote going to the winning candidate) to 1 (50% of the vote going to each major party candidate).

Results and Discussion

Fig 1 shows the results of the county-level estimated turnout as a function of the competitiveness of the state's election, the interaction between the state's competitiveness with snow and rain, the main effect of both rain and snow, and the control variables listed in the previous section. Year fixed effects are estimated but not displayed. We show the aggregate model, Model 0, which we—like Fraga and Hersh (4)—generated with the ls.mixed command in the Zelig package of R statistical software, and which is largely consistent with Model 3 from Fraga and Hersh (4, p. 351). We also show separate models for Republicans, Democrats, and "other" candidates (Models 1, 2, and 3, respectively). What is most striking in Models 1-3 of Table 1 is the diversity in magnitude, direction, and statistical significance of the covariates, which supports our claim for the need to disaggregate the electorate by party when modeling voter costs and voter turnout

Fig 1. The impact of competitiveness and inclement weather on party turnout. Standard errors are in parentheses.

Simulated results, which we show in Fig 2, help to interpret the model given the complexity introduced by so many covariates, particularly the interaction effects. Specifically, Fig 2 is a simulation of the change in turnout for "other" candidates as a result of rainfall, holding all other covariates at their mean, and with separate simulations for uncompetitive elections (gray line, 30% margin of victory or greater) and competitive elections (black line, 4% margin of victory or less).

Fig 2. Change in county turnout for "other candidates" as a function of rainfall

As expected, we find that while precipitation has little effect on turnout for non-major party candidates in uncompetitive election states, it has a large effect on turnout in competitive election states. Specifically, we estimate that 1 inch of rainfall is associated with an approximately 1% decline in absolute turnout for "other" candidates, and 2 inches of rainfall is associated with an approximately 2% absolute decline in absolute turnout for "other" candidates. Considering that "other" party candidates typically garner only a small fraction of the total turnout in most elections, a 1 or 2% absolute change in turnout represents a large relative change in turnout for "other" party candidates. Furthermore, because we know from Fraga and Hersh (4) that overall turnout is unaffected by precipitation in competitive election states, it follows that precipitation must be associated with an increase in turnout in competitive states for at least one of the major parties. Which party is disproportionately the beneficiary of this increase in turnout is the question to which we now turn.

Should Republicans Pray for Rain?

Fig 3 is a simulation of the change in turnout for each party versus rain for a competitive county (4% margin of victory or less), holding all other covariates at their mean. By untangling the effect of rain on turnout in competitive elections by party we see that although aggregate turnout is unaffected by rain in competitive elections, this is not true for each party candidate. Fig 3 shows that on average during this period Republicans usually should “pray for rain” in competitive elections.

Fig 3. Change in county turnout as a function of rainfall in competitive election states (1972-2000).

However, as expected, the claim that “Republicans should pray for rain” is not the entire story. While no definitive claim can be made based on data from any single election, we find that when we exclusively consider the effect of precipitation on county turnout in competitive election states in the 2000 election—the only year considered in which the major “other” party candidate, Ralph Nader, was ideologically closer to the Democrats than the Republicans—the trend reverses, such that Democratic turnout increases as a function of rain while turnout for “other” party candidates decreases as a function of rain (Fig 4).

Fig 4. Change in county turnout as a function of rainfall in competitive election states (2000).

Notably, in competitive states in the 2000 election, we also find that the precipitation is associated with decreased Republican turnout. One might hypothesize that in the 2000 election, rain-induced risk aversion also worked to bolster Democratic turnout at the expense of Republican turnout because Al Gore was the candidate for the incumbent party and because his platform was arguably more risk averse than Bush’s (e.g., his Medicare “lockbox” vs. Bush’s tax cuts). Of course, while this is broadly consistent with our theoretical explanation, we caution that it is merely speculative because it is based solely on data from battleground states in one election. Nonetheless, this result is important in that it rests in stark contrast to prior research. While Gomez et al. (3) suggested that Florida rains cost Al Gore the election in 2000, we find that precipitation led to relatively large increases in turnout for the Democratic candidate that year. Thus, we suggest that Al Gore would have won the 2000 presidential election if it rained *more* in Florida, not less.

Conclusion

While political scientists have long considered how inclement weather affects election outcomes, they have assumed that it does so through increasing the cost of showing up to the polls. Here, by turning to the psychology literature, we have drawn attention to the effect of inclement weather on a second behavior: voters' decisions once they arrive at the polls. In fact, while the effect of inclement weather on voter turnout may dwarf the psychological effect of inclement weather on voters' choices in the aggregate, our results suggest that the psychological effect of weather on voters' choices may play a larger role in impacting actual election outcomes because voter turnout is resilient to inclement weather in competitive election states. Furthermore, our results show that while rain historically tends to benefit Republicans, the effect of rain on voter behavior is more complex than initially thought. According to our analysis, the beneficiary of rain varies in any given election year depending on the ideology of the leading non-major party candidate. Our model supports the hypothesis that rain might influence a supporter of a non-major party candidate to take a "rain check" on voting for the third party in favor of either the Republican or Democrat in competitive election contexts, rather than risk the feelings of regret that many who voted for Ralph Nader in Florida in the 2000 election feel to this day. Our central contribution is the recognition that rain impacts voter psychology—

particularly in competitive election contexts—in addition to the cost of voting, and through doing so weather may have substantive impacts on election outcomes.

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Fig 1 Click here to download Figure Fig1.tif

	Dependent variable: presidential election county turnout			
	Model 0	Model 1	Model 2	Model 3
	Aggregate	Republicans	Democrats	Other
Rain	−4.022***	−1.407***	−6.452***	2.444***
	(0.444)	(0.385)	(0.404)	(0.205)
Snow	−0.407	5.004***	−0.879	−3.601***
	(0.689)	(0.592)	(0.621)	(0.317)
Competitiveness	5.754***	−4.355***	13.538***	−2.726***
	(0.321)	(0.312)	(0.328)	(0.152)
Education	0.674***	1.281***	−1.008***	0.618***
	(0.049)	(0.080)	(0.084)	(0.025)
Income	0.152*	2.078***	−0.847***	−0.219***
	(0.087)	(0.154)	(0.163)	(0.045)
% African American	−0.005*	−0.098***	0.093***	−0.029***
	(0.003)	(0.007)	(0.007)	(0.001)
Farms per Capita	17.734***	51.077***	−14.942***	0.337
	(1.013)	(2.300)	(2.444)	(0.525)
Registration Closing Date	−0.060***	0.021***	−0.100***	−0.023***
	(0.003)	(0.005)	(0.006)	(0.002)
Motor Voter	−0.157	−0.586***	−0.115	0.469***
	(0.102)	(0.097)	(0.102)	(0.048)
Gubernatorial Election	−0.236***	−0.337***	0.081	−0.052
	(0.073)	(0.123)	(0.130)	(0.037)
Senatorial Election	0.202***	0.467***	−0.357***	0.012
	(0.062)	(0.052)	(0.054)	(0.028)
Turnout Lag	0.804***	0.344***	0.167***	0.049***
	(0.004)	(0.005)	(0.005)	(0.002)
Average Rain	−0.056	−6.249***	9.116***	0.978***
	(0.636)	(0.811)	(0.852)	(0.315)
Average Snow	6.036***	−0.012	7.251***	0.306
	(0.460)	(0.593)	(0.623)	(0.228)
Rain x Competitiveness	3.980***	2.729***	6.787***	−4.037***
	(0.606)	(0.524)	(0.549)	(0.279)
Snow x Competitiveness	−0.012	−6.706***	0.157	5.146***
	(0.811)	(0.698)	(0.732)	(0.374)
Constant	7.378***	14.596***	4.070***	1.322***
	(0.388)	(0.574)	(0.606)	(0.193)
Observations	24,757	24,757	24,757	24,757
Log Likelihood	−72,606.280	−71,700.450	−72,938.200	−53,590.570
Akaike Inf. Crit.	145,264.600	143,452.900	145,928.400	107,233.100
Bayesian Inf. Crit.	145,475.600	143,663.900	146,139.400	107,444.200
Note:			*p<0.1; **p<0.05; ***p<0.01	

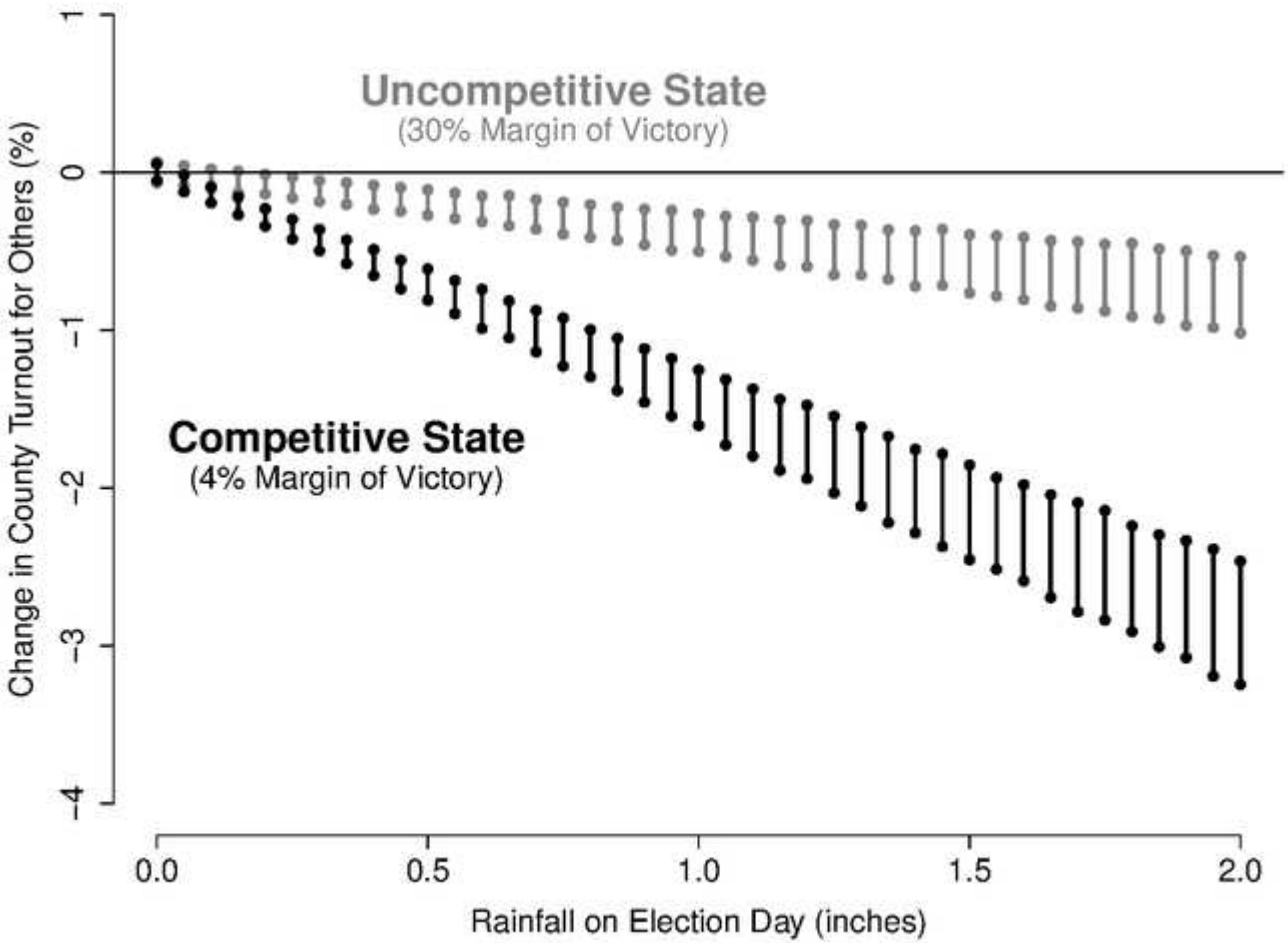
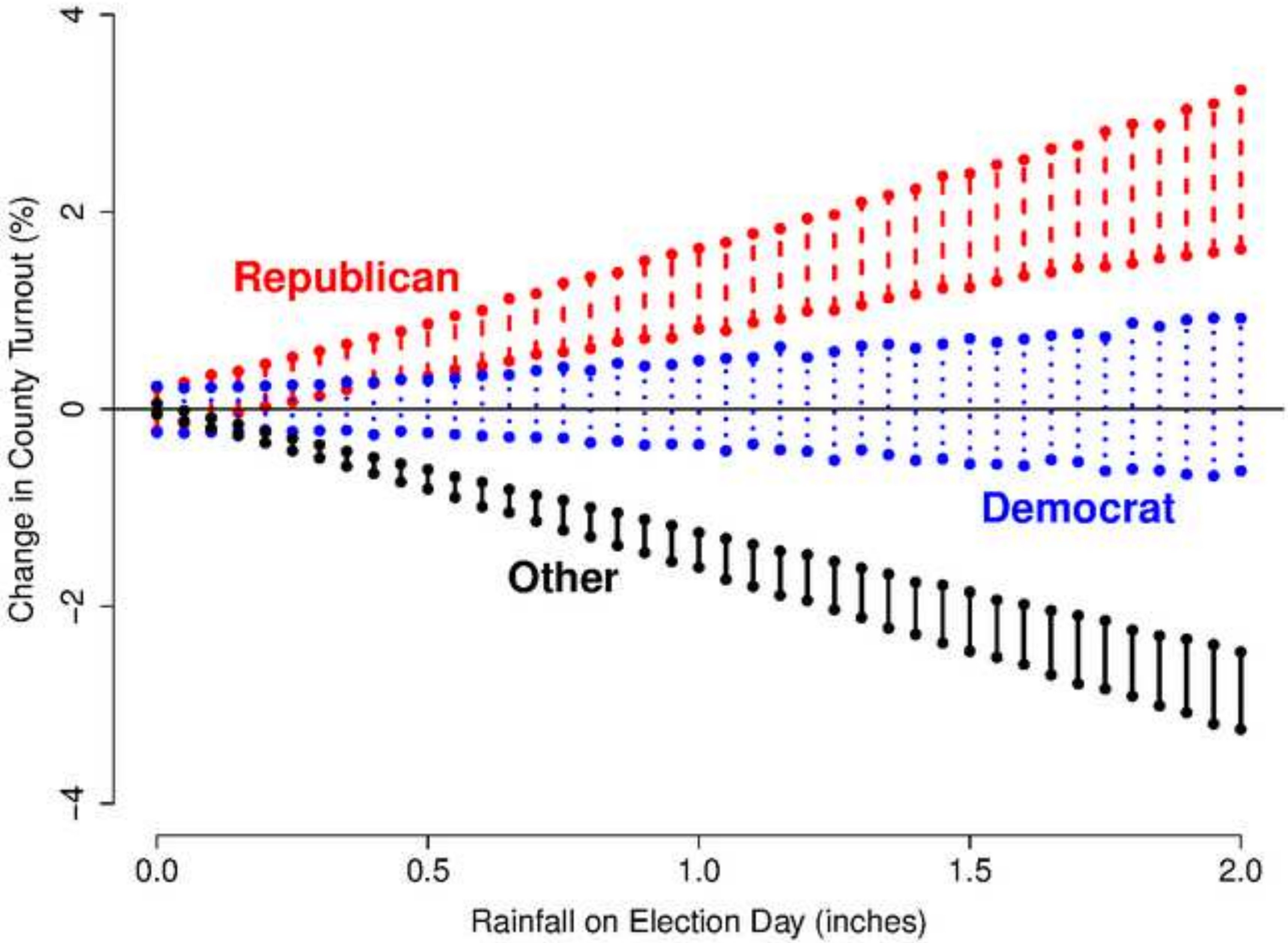
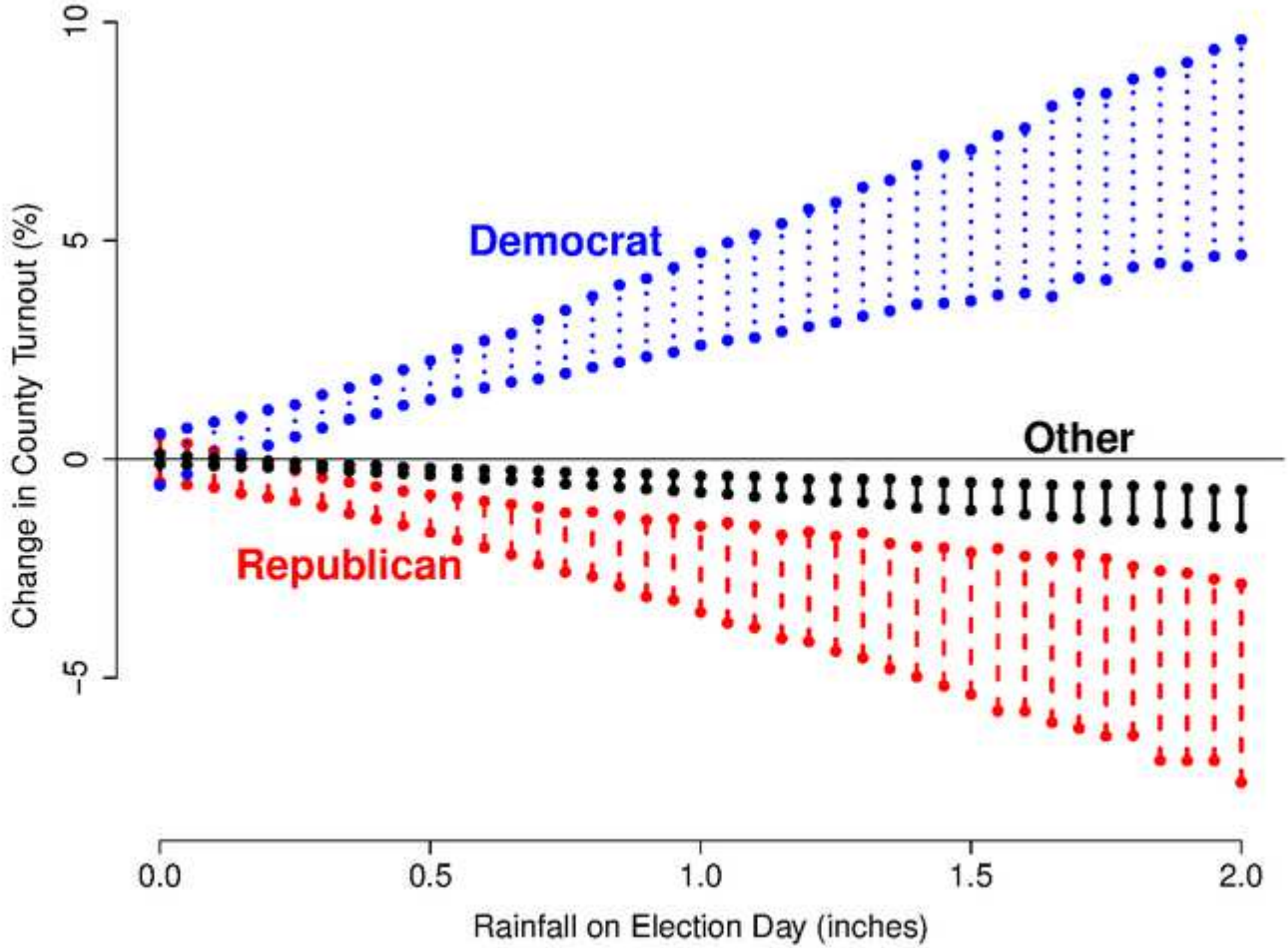

Uncompetitive State
(30% Margin of Victory)
Competitive State
(4% Margin of Victory)
Change in County Turnout for Others (%)
1
0
−1
−2
−3
−4
0.0
0.5
1.0
1.5
2.0
Rainfall on Election Day (inches)

Fig 3

Click here to download Figure Fig3.tif




Democrat
Other
Republican
10
5
0
−5
Change in County Turnout (%)
0.0
0.5
1.0
1.5
2.0
Rainfall on Election Day (inches)

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DuhaimeMoulton2016DataFile.dta

Supporting Information - Rcode

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Supporting Information

DuhaimeMoulton2016ReplicationCode.R