ARE VOTERS IRRATIONAL?

THE UNEDUCATED AND PARTISAN ONES ARE

Andrew J. Healy *

Loyola Marymount University

May 15, 2007

* Contact information: ahealy@lmu.edu

I thank Shawn Cole, Alan Gerber, Tim Groseclose, Ebonya Washington, and Chinda Wongngamnit for helpful comments on earlier drafts of this paper and Eric Patashnik for helpful discussions. I also thank the National Science Foundation for the support of a graduate fellowship when I started thinking about this project. All errors are my own.

Abstract

This paper uses state-level election returns and individual-level survey data to show that American voters have systematically punished the incumbent party for extreme weather in presidential election years. A moderate drought has cost the incumbent party an average of 2.6 percent of the presidential vote in rural areas, with no significant effect in urban and suburban areas. Weather's impact has diminished over time as agriculture's economic importance has decreased. The results indicate that a voter's partisan preferences and education predict his rationality. Election-year weather does not significantly affect the behavior of moderate voters or those voters who have attended college.

The idea that voters respond to economic conditions accords with casual observation, has been verified by empirical research, and is almost universally accepted by political scientists.[1] While there is little doubt that voters engage in economic voting, different causes appear to motivate economic voting in different environments. It has generally been argued that economic voting in the United States arises from "sociotropic" behavior, as voters respond primarily to national economic conditions (Kinder and Kiewiet 1979, Markus 1988). In a variety of other countries, personal financial conditions, or "pocketbook" concerns, have apparently had greater influence on voters (Lewis-Beck and Paldam 2000; Gomez and Wilson 2006).

Whether voters are motivated by sociotropic or pocketbook concerns, it is unclear to what extent economic voting is a rational act. If voters either use economic conditions to ascertain the extent to which the incumbent is responsible for past and current conditions or to predict how the incumbent's reelection will affect future conditions, then economic voting may be rational. Recent research provides evidence in favor of this model of rational economic voting. It appears that well-informed voters are more likely to engage in economic voting (Krause 1997; Duch 2001; Gomez and Wilson 2006). Also, voters show a greater tendency towards economic voting in those countries where responsibility for economic policies can be more clearly assigned to a specific individual or party (Powell and Whitten 1993).

Although these results suggest that economic voting may be at least somewhat rational, there is little evidence to suggest that voters effectively link policies to economic conditions. In fact, many economists believe that the connections between a president's policies and short-run growth are either slight or nonexistent. Two different explanations, then, could account for the

[1] The finding was first demonstrated for American voters (Kramer 1971; Fair 1978) and has since been demonstrated in a range of countries, including France (Lewis-Beck 1983), Germany (Alford and Legge 1984), and Canada (Monroe and Erickson 1986). Economic voting has also been investigated in many comparative studies (Paldam 1991; Powell and Whitten 1993).

fact that voters respond strongest to economic conditions when responsibility for policies can be determined. Under the first, voters correctly give credit and blame to the incumbent for the conditions caused by his policies. Under the second, the voters attribute credit and blame to the incumbent, but his policies actually have little to do with economic conditions.

To test these competing hypotheses, this paper considers how voters respond to extreme weather in an election year, a factor that could affect a voter's income but is beyond any politician's control.[2] Perfectly rational voters would not systematically reward or penalize the incumbent party for the weather. Responding to weather could be rational in any given election since individual incumbents may respond well or poorly to the weather event, but rational voters will not systematically base their votes on factors like weather across the span of many elections.

In addition to testing whether voters are rational, I also use individual-level survey data to test theories about the kinds of voters who are prone to conditioning their votes on the weather. By determining the underlying causes of voter rationality, this paper goes beyond two recent working papers that also test for voter rationality by examining how voters respond to circumstances beyond an incumbent's control. Wolfers (2006) looks at whether US governors of oil-producing states are rewarded and punished for shifts in the international price of oil. He concludes that votes do depend in part on the price of oil. Achen and Bartels (2004) use state-level presidential election returns to conclude that weather in an election year influences the number of votes that the incumbent receives. Each of these papers rejects the fully rational voting model.

[2] Other research has established that the weather can directly affect voting behavior. Rain or snow on election day has historically benefitted the Republican presidential candidate (Gomez, Hansford, and Krause 2007). Unlike the response to election year weather described in this paper, voters' responses to election day weather may be rational. The average Democratic voter may have a higher cost of getting to the polls in bad weather than the average Republican voter.

Likewise, the results in this paper reject the rational model. State-level presidential election returns show that a moderate drought has cost the incumbent party about 1.3 percent of the vote in farm states, with no significant effect in non-farm states. Individual-level voter survey data shows that a moderate drought has, on average, cost the incumbent party about 2.6 percent of the vote in rural areas in all states. Weather has no significant effect on voting in urban and suburban areas. Year effects and state fixed effects are included in the regressions to ensure that these estimates come from weather variation across states in a given election year.

The data also shows that the effect of weather on voting behavior has fallen over time, just as the effect of weather on a state's per-capita income has fallen. Weather had a significant effect on voting behavior and income before 1974, but no significant effect on either from 1974 to 2005.

One fortunate aspect of the individual-level American National Election Studies (ANES) data is that it asks its respondents who they voted for in the previous presidential election. I use respondents' previous votes to create a quasi-panel out of the individual-level data. In other words, I look at how voters change their votes across elections, and how the weather influences those changes. The data shows that the weather affects the likelihood that voters change their party of choice. Moreover, the data shows that weather affects only voters who previously supported the incumbent party. Rural voters who previously supported the incumbent party become less likely to support it again when a drought hits.

Finally, the individual-level data makes it possible to test theories about which kind of voters are prone to irrationality. The data shows that moderate voters do not condition their votes on the weather. In contrast, the weather significantly affects the decisions made by strongly partisan voters. Likewise, the weather affects the probability that voters with high

school education or less change their votes, but the weather has no effect on voters who have at least some college education.

Section 2 discusses previous empirical and theoretical research on how voters respond to economic conditions and the rationality of those responses. Section 3 describes the weather and voting data that is used for the analysis in this paper. Section 4 presents the results obtained by analyzing presidential election results at the state level from 1896 to 2004. In Section 5, I identify the characteristics of rational and irrational voters by looking at individual voting behavior in presidential elections from 1948 to 2000. Section 6 concludes.

Economic Voting: Theory and Evidence

Previous research on economic voting suggests that, at the least, there are limits to voters' abilities to use economic conditions to inform their decisions. Voters' perceptions of economic conditions can be biased by misleading media reports (Hetherington 1996). Voters also appear to respond more strongly to negative economic news than to positive news (Nannestad and Paldam 1997). This evidence is consistent with economists' and psychologists' findings that individuals experience greater pain from losses than they experience joy from gains (Kahneman and Tversky 1979), but inconsistent with a rational accounting of the incumbent's performance.[3] For this reason, it might be expected that, compared to average weather, bad weather would hurt an incumbent more than good weather would help. As will be shown later, this asymmetry does occur.

[3] Adding to the research on how economic conditions affect voting decisions is a literature in economics that shows how economic voting can distort a government's incentives. A government has incentive to inflate the economy before an election at the expense of longer term economic health (Rogoff and Sibert 1988; Rogoff 1990). In Rogoff (1990), a more competent leader may be able to achieve higher income levels with the same levels of government spending and taxes. To demonstrate competence, a leader then has incentive to ensure that short-term economic growth is high. The policy outcome is not the first-best because the leader overemphasizes short-term growth, even though voters can determine an incumbent's competence from the economic and policy outcomes.

Moreover, there are numerous examples that suggest that events beyond a politician's control have affected voting behavior. The incumbent Republican party suffered electoral losses in Nebraska in 1890 that coincided with a severe drought and consequently low harvest (Barnhart 1925). Shark attacks in New Jersey appear to have cost Woodrow Wilson votes in two New Jersey towns in the 1916 election (Achen and Bartels 2004). The unknown Social Credit Party won provincial elections in Alberta after a drought caused poor harvests (Irving 1959). The New York Mets' surprising win in the 1969 World Series may have helped incumbent John Lindsay to a surprising win in the mayoral election a few weeks later (Cohen 1988). In addition, Hurricane Betsy appears to have cost the mayor of New Orleans votes in 1965 (Abney and Hill 1966) and Tropical Storm Allison appears to have cost the incumbent mayor of Houston votes in 2001 (Arceneaux and Stein 2006).

It is important to distinguish between which of these examples may describe rational behavior and which ones cannot. In the last two examples, voters punished a politician who was deemed to have performed poorly in preparing for the disaster that cost him votes (Abney and Hill 1966, Arceneaux and Stein 2006). The other examples, while not conclusive, suggest that voters may make decisions based, at least in part, on their personal successes, failures, and emotions, and not simply a rational accounting of the circumstances for which the incumbent is responsible. Barnhart (1925, 540) proposes a plausible psychological explanation for how such behavior may have arisen in the case of Nebraska in 1890. He writes of the drought:

> The situation of many farmers forced them to think about the things that had brought about that situation. This contemplation resulted in a determination to remedy such matters as lay within their power. They could not make it rain, but they thought they could lower railroad rates…The farmers were already incensed at the treatment they were getting from the railroads. The drouth (sic) not merely made the economic position of the farmer temporarily worse, but it put him in a receptive frame of mind for the arguments of the Independent Party leaders.

In other words, bad times may cause voters to focus on what they dislike about the incumbent party, including conditions that it may actually be able to control, like the railroad rates in the above passage. Voters who behave in this way are best described as partially rational. They attempt to account for the incumbent's performance when deciding how to vote; however, their perceptions are biased by personal events beyond any politician's control.

The Data

The analysis in this paper utilizes voting data from a series of US presidential elections. I look first at aggregate voting behavior across states from 1896 to 2004 to see whether or not votes for the incumbent party depend on the weather in the year of the election. Then individual-level voting data is used both to confirm the state-level results and to determine the kinds of voters who deviate from rationality.

For the state-level analysis, I used election returns collected by the Interuniversity Consortium for Political and Social Research (ICPSR) for the 24 presidential elections from 1896 to 1988. For the elections that took place from 1992 to 2004, the data comes from the US Election Atlas, an online database.[4] I combined the election data with the National Climatic Data Center's measurements of the Palmer Drought Severity Index (PDSI).[5] This index estimates the degree of moisture in the soil associated with recent weather conditions. If the PDSI is zero, recent weather conditions are consistent with a balance between moisture supply and the soil's demand for water. Hot and dry conditions will lead to negative PDSI values, while

[4] The state-level election data for 1896 to 1988 comes from ICPSR study number 7757. The state-level election data for 1992 to 2004 was accessed at http://uselectionatlas.org/RESULTS in June 2006. Returns from Alaska, Hawaii, and the District of Columbia are not included in the analysis.
[5] The NCDC data was accessed at ftp://ftp.ncdc.noaa.gov/pub/data/cirs/ in June 2006.

cold and wet conditions lead to positive PDSI values. Extreme values of the PDSI indicate conditions that are unfavorable for agriculture. Table 1 describes how the PDSI works.

I combine the state-level election returns with state-level income data reported by the Bureau of Economic Analysis. This data shows how weather's effect on income has changed over time.

For the individual-level analysis, I used data from the American National Election Studies from 1948 to 2002.[6] This dataset contains information about the respondents' votes in recent elections and a variety of household characteristics. Included in the ANES data is information about a voter's education, his age, and his partisan preferences. Also included is a voter's choice in the previous presidential election. As a result, I can look at weather's effect on how voters change their behavior from the previous election.

Testing for Voter Rationality at the State Level

State-level election returns make it possible to determine if voters' decisions systematically depend on the weather. To test this hypothesis, I regress the incumbent party's vote share in a state on the weather in the election year and a set of controls. These controls consist of a full set of state fixed effects, year effects, and the share of votes received by third-party candidates in any given election. Since we have many more voters in the sample than years, it is important to include the year effects (Wooldridge 2003, 170; Gomez, Hansford, and Krause 2007). The presence of the state and year effects together means that the estimated effect of weather on voting comes from variation between states in the weather in any given election year.

[6] The ANES dataset is held at the ICPSR as study number 8475.

Similar to Achen and Bartels (2004), I measure weather conditions by the absolute value of the average of the PDSI between May and October in state *s* in year *y*.[7] High values correspond to extreme weather in the election year. Since a change of 1.5 in the PDSI can reflect a change from the middle of the normal range (0.75) to the middle of the mild to moderate drought range (2.25), I also divide the PDSI measure by 1.5. An increase of 1 in this weather index (denoted by $Weather_{sy}$) is then equivalent to a change from normal conditions to moderate drought conditions. Defining the weather index in this way makes the regression coefficients easily interpretable.

The dependent variable used in the regression is the incumbent party's share of the total vote in the presidential election. The incumbent party's share in state *s* in election *y* is modeled as

$$Share_{sy} = \alpha + \gamma_s + \eta_y + \beta Weather_{sy} + \varepsilon_{sy}, \quad (1)$$

where γ_s is a set of state fixed effects and η_y is a set of year effects.

I also consider a specification based on the change in the vote share that the incumbent party received. The vote share that the incumbent received in the previous election captures the state's preference for the incumbent in the previous election, before the weather events occurred.

$$(Share_{sy} - Share_{s(y-4)}) = \alpha + \eta_y + \beta Weather_{sy} + \varepsilon_{sy}, \quad (2)$$

Estimating equation (2) provides an estimate of the effect that the weather has on the change in a state's preferences for the incumbent party. Panel A of Table 2 reports the results of estimating (1) and Panel B reports the results of estimating (2).

[7] Achen and Bartels (2004) use the Palmer Hydrological Severity Index (PHDI), which is similar to the PDSI. Results are almost identical if the PHDI is used instead of the PDSI. I use the PDSI because climate scientists consider the PDSI the standard measure of weather's impact on soil health (Palmer 1965). All results retain their significance and nothing of substance changes if the PHDI is used instead.

To account for the presence of important third-party candidates like George Wallace in 1968 and H. Ross Perot in 1992, the regression can also be expanded to include the share of votes earned by third-party candidates in the election in the set of control variables.[8] As Table 2 shows, the results are not significantly affected by the inclusion or exclusion of the third party vote share. Columns (3) and (4) in Table 2 include the third-party vote share. Columns (1) and (2) do not. The results indicate that weather has a negative effect on the vote share that the incumbent received, but only in farm states. Over the span of the individual-level data examined in the next section (1948-2000), 80% of American farmers have lived in three regions as defined by the ICPSR: East North Central, West North Central, and the Solid South. Only in the states in these regions does weather have an effect on voting behavior.[9] The point estimate in column (2) of Panel A indicates that a change from good soil conditions (PDSI = 0.75) to a six-month moderate drought (PDSI = 2.25) costs the incumbent on average about 1.32% of the two-party vote in farm states. Panel B shows the same estimate of 1.32% for the change in the incumbent's vote share caused by a moderate drought. At the 5% level, we can reject the hypotheses that, in farm states, the weather has no effect on the incumbent party's share of the vote (p = .022) and that the weather has no effect on the change in the incumbent party's share of the vote (p =.006).

Result 1: Weather in the year before the election significantly affects voting only in farm states, where a moderate drought costs the incumbent party about 1.3% of the vote.

[8] Failing to account for third-party candidates could bias the estimate of β if it happened to be the case that unusually good or bad weather happened in those few years when important third-party candidates run. Another issue is the potential endogeneity of third-party candidacies. Bias could arise if third-party candidates choose to run in bad weather years because they sense an opportunity to gain votes, for example. This issue is discussed in greater detail in the section on specification issues.

[9] The East North Central states are Indiana, Illinois, Michigan, Ohio, and Wisconsin. The West North Central states are Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota. The Solid South states are Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Texas, and Virginia.

Breaking down why and when weather has affected voting behavior

Table 3 shows that weather has had a significant effect on per-capita income growth only in farm states, and that this effect exists only for the earlier years of the sample. From 1929-1974, a moderate drought resulted in 1.1% lower per-capita GDP growth in farm states, a significant effect ($p = .006$). The regression estimates that weather had no significant effect on income in non-farm states, even from 1929-1974. Weather's effect on income in farm states disappears for the later years in the sample. From 1974-2005, the regression estimates that the weather had no significant effect on income. Weather had a significant and large effect on per-capita income, but only in farm states and in earlier years.

Similarly, weather had a significant and important effect on voting behavior, but only in farm states in earlier years. Table 4, which uses the change in the incumbent party's vote share as the dependent variable, shows that a moderate drought cost the incumbent party an average of 1.57% of the vote in farm states from 1896-1972, a significant effect ($p = .006$). Weather cost the incumbent party an average of 1.06% of the vote from 1976-2004. This effect is estimated less precisely and the effect is not significant ($p = .134$). Weather had no significant effect on voting behavior during either time period in non-farm states.

Result 2: Weather has significantly affected income and voting behavior only in farm states in earlier years.

Specification Issues

The randomness of the weather should ensure that the estimated effect of weather on the incumbent's vote share is unbiased. Still, there is one way in which bias could arise.

Suppose that a potential third-party candidate is more likely to enter the race when he perceives weakness in the incumbent and that adverse weather conditions make it more likely that the incumbent is weak. The incumbent's vote share would go down because the third-party candidate chose to enter. To avoid assigning the effect of third-party entry to the weather, the third-party's share of the vote is included in the regression. Including the third-party vote share ensures that the effect of weather is not overestimated. The regression results assign to weather only the effect that it has on voting behavior, taking the candidate slate as given. Also, if third-party entry decisions are made before the election year, no bias will arise.

Testing for Voter Rationality at the Individual Level

In this section, I use individual-level data from the American National Election Studies (ANES) to test a variety of hypotheses that cannot be tested with the state-level data. I use the data on individual voters' characteristics to identify the kinds of voters who are prone to acting in an irrational way.

First, I apply the same model to the individual voting data that was applied to the state-level returns. Define $IncumVote_{isy}$ to be one if a voter *i* chooses the incumbent party in the presidential election and zero if the voter chooses a different party. Analogous to the state-level regression, $IncumVote_{isy}$ is modeled as a function of state fixed effects, year effects, and the weather.[10] The regression equation is:

$$IncumVote_{isy} = \alpha + \gamma_s + \eta_y + \beta Weather_{isy} + \varepsilon_{isy}, \qquad (3)$$

Table 5 presents the results from using a linear regression and a logit regression to estimate (3). The *t*-statistics for each regression are nearly the same, where the logit coefficients

[10] Also included in the regression is the incumbent party's vote share in the state in a given election, which accounts for statewide preferences for the incumbent party, and the third-party vote share in the state.

are reported as odds ratios. The regression shows that the weather has a significant effect on how rural voters behave, and no significant effect on the behavior of voters who live in urban and suburban areas. The linear regression estimates that moving from normal soil conditions to a moderate drought decreases the probability that a rural voter selects the incumbent party by 2.56%, a significant effect (p = .020). This estimate of the effect of weather on the voting behavior of all rural voters is about twice as large as the effect estimated in the previous section for all voters in farm states, which even in earlier years include many non-rural voters.

Result 3: The individual decisions in the voter survey indicate that weather has a significant effect on voting behavior only in rural areas, where a moderate drought makes a voter about 2.6% less likely to support the incumbent party.

Looking at How Voters Change Their Behavior

As discussed earlier, the ANES data includes information on respondents' votes in the previous presidential election. This data makes it possible to see how the weather changed voters' preferences across elections. Looking at changes in voting behavior creates a cleaner test of how the weather affects voting behavior since the individual's previous vote controls for time-invariant information at the level of the voter.

To look at how voters change their decisions across elections, consider the following specification:

$$(IncumVote_{isy} - IncumVote_{is(y-4)}) = \alpha + \eta_y + \beta Weather_{isy} + \varepsilon_{isy}, \quad (4)$$

The dependent variable $IncumVote_{isy} - IncumVote_{is(y-4)}$ is -1 for a voter who chose the incumbent party in the previous election and does not choose it in the present election, 0 for a voter who

chooses the same party in each election, and 1 for a voter who did not choose the incumbent party in the previous election but does choose it in the present election.

Panel A presents the results of estimating (4) for all voters. Similar to the results in Table 5, the regression results estimate that a moderate drought makes a rural voter 2.84% more likely to change his vote. Panels B and C indicate the behavior that is driving this result. Panel B shows that a moderate drought makes rural voters 3.84% more likely to switch away from the incumbent party, a significant effect. On the other hand, Panel C shows that the weather does not have a significant effect on the probability that voters switch to the incumbent party.

Result 4: A moderate drought makes a rural voter significantly more likely to switch away from the incumbent party, but does not affect the probability that a rural voter switches to the incumbent party.

Breaking Down the Effect of Weather on Individual Behavior

As with the state-level results, the ANES data shows that weather significantly affects voting behavior only in earlier years. Table 7 presents the results obtained by estimating (4) separately for 1948-1972 and for 1976-2004. A moderate drought made rural voters 3.42% more likely to switch away from the incumbent party from 1948-1972, a significant effect. From 1976-2004, the regression estimates that a drought made a voter 0.19% less likely to choose the incumbent party, an insignificant effect.

The result that weather causes voters to switch away from, but not towards, the incumbent party, suggests another test that I conduct in Table 8. There I estimate the effect of bad weather in comparison to good weather. The results in Table 8 demonstrate that voters

respond only to bad weather, but do not respond to good weather. In other words, voters punish the incumbent for bad weather and do not reward it for good weather. Together with the results in Table 6, these results complete the description for the conditions under which the weather affects voting behavior: In the past, rural voters have switched away from the incumbent party when bad weather has occurred.

Result 5: Weather affected rural voters' decisions in earlier years. Bad weather increased the probability that rural voters abandoned the incumbent party, while good weather did not benefit the incumbent party.

Which Voters Act Irrationally?

In addition to demonstrating the ways in which the weather has affected voting behavior, the individual-level data reveals the kinds of voters who are prone to irrationality. Specifically, we might expect more educated voters to be less likely to condition their votes on the weather. We also might expect older voters to show greater levels of rationality or for voters' partisan preferences to be related to their rationality.

Table 9 shows the results of testing for how voters with different levels of education, ages, and ideologies may respond differently to extreme weather. Panel A demonstrates that voters with high school education or less are significantly more likely to respond to the weather than are other rural voters. Voters with low levels of education are 2.66% more likely to switch away from the incumbent party after a moderate drought, a significant effect. In contrast, voters with high levels of education are only 1.41% more likely to switch and the effect is insignificant.

These results are not driven by the fact that farmers have lower levels of education. Columns (3) and (4) in Panel A exclude farmers from the analysis. The results are similar to the results in columns (1) and (2) that include all occupations in the analysis. Among non-farmers, a moderate drought makes a voter with high school education or less 2.67% more likely to switch away from the incumbent party, a significant effect. A moderate drought makes college-educated non-farmers only 1.20% more likely to switch, and this effect is insignificant.

The results for age suggest that age does not affect how voters respond to the weather. Voters who are older than 40 are 2.38% more likely to switch away the incumbent party after a moderate drought. Voters who are 40 or younger are 2.12% more likely to switch. Each effect is marginally significant. The data indicates that the weather affects young and old voters in similar ways.

In Panel C, I demonstrate that strongly partisan voters are more likely to respond to the weather. In the ANES data, voters express on a scale from 1 to 7 the extent to which they identify with the Republican and Democratic party. From this variable, I define a new variable that ranges from 1 to 7, with higher numbers indicating greater agreement with the incumbent party. I define a voter who rates between 1 and 5 as a moderate voter and a voter who rates from 6 to 7 as one whose ideology strongly agrees with the incumbent. Few of the voters who rate 1 or 2 voted for the incumbent party in the first place. Of the voters who chose the incumbent party in the previous election, only 13% fall in the 1 or 2 category. The other 87% are either fall somewhere between 3 and 5, the middle of the ideological spectrum.

These mostly moderate voters are 1.28% more likely to switch away from the incumbent after a moderate drought, an insignificant effect. In contrast, a drought makes a voter whose ideology strongly agrees with the incumbent party's 3.25% more likely to switch, a significant

effect. Notice that this estimate may underestimate the true effect of the weather on the most partisan voters, since the weather may cause some of those voters to change their partisan preferences. As a result, the 3.25% estimate is a lower bound for the true effect of the weather on the most partisan voters. The data shows conclusively that the most partisan voters are also the voters most prone to irrationally conditioning their votes on the weather in the election year.

Result 6: More educated voters and more moderate voters are less prone to irrationality. The weather significantly affects the decisions made only by voters with a high-school education or less and by voters who strongly identify with the incumbent party.

Discussion

This paper has analyzed voters' responses to election-year weather to demonstrate that voters punish politicians for circumstances beyond their control. Both state-level election returns and individual-level voter surveys show that a moderate drought has cost the incumbent party a significant number of votes across a series of elections. The data also strongly suggests that weather affects voting through its effect on voters' incomes. Weather has no significant effect on voting behavior or income in urban and suburban areas or in recent years, but it has a significant effect on both in rural areas in earlier years.

Since voters respond to weather-caused welfare losses, their behavior is not rational. Even if voters condition their choices on politicians' responses to the weather, the choices of rational voters will not be systematically correlated to the weather over a series of many elections. A rational voter will reward an officeholder who responds well to the weather and

punish one who responds poorly. The fact that extreme weather causes voters to systematically change their votes away from the incumbent party indicates irrational behavior.

Moreover, the individual-level survey data indicates that voters' identifiable characteristics can predict the extent of their rationality. The weather has no significant effect on the voting decisions that well-educated and moderate voters make. On the other hand, the weather has a significant effect on the decisions that made by voters with a high-school education or less and by voters who are strongly partisan. These results suggest that future research into voter rationality should carefully consider individual voters' characteristics.

The behavior of American voters suggests another interesting direction for future research. Weather affects income significantly more in developing countries where irrigation is often lacking and agriculture is more important. In these countries, weather is likely to still have a large and significant effect on voting behavior. Analyzing data from developing countries will show to what extent the results in this paper generalize to other environments. For example, it will be interesting to see if voting behavior in other countries will confirm that it is generally the case that less educated voters are more prone to irrationality.

References

Abney, F. Glenn, and Larry B. Hill. 1966. "Natural Disasters as a Political Variable: The Effect of a Hurricane on an Urban Election." *American Political Science Review* 60:974-81.

Achen, Christopher H. and Larry M. Bartels. 2004. "Blind Retrospection: Electoral Responses to Drought, Flu, and Shark Attacks." working paper, Princeton University.

Alesina, Alberto and Howard Rosenthal. 1995. *Partisan Politics, Divided Government, and the Economy*. Cambridge: Cambridge University Press.

Alesina, Alberto, Nouriel Roubini, and Gerald D. Cohen. 1997. *Political Cycles and the Macroeconomy*. Cambridge: MIT Press.

Alford, John R. and Jerome S. Legge, Jr. 1984. "Economic Conditions and Individual Vote in the Federal Republic of Germany." *Journal of Politics* 46:1168-81.

Arceneaux, Kevin, and Robert M. Stein. 2006. "Who is Held Responsible When Disaster Strikes? The Attribution of Responsibility for a Natural Disaster in an Urban Election." *Journal of Urban Affairs* 28:43-53.

Barnhart, John D. 1925. "Rainfall and the Populist Party in Nebraska." *American Political Science Review* 19:527-540.

Bertrand, Marianne and Sendhil Mullainathan. 2001. "Do CEOs Set Their Own Pay? The Ones Without Principals Do." *Quarterly Journal of Economics* 116:901-32.

Cohen, Stanley. 1988. "A Magic Summer: The '69 Mets." San Diego, CA: Harcourt.

Conover, Pamela J., Stanley Feldman, and Kathleen Knight. 1986. "Judging Inflation and Unemployment: The Origins of Retrospective Evaluations." *Journal of Politics* 48:565-88.

Duch, Raymond M., Harvey D. Palmer, and Christopher J. Anderson. 2000. "Heterogeneity in Perceptions of National Economic Conditions." *American Journal of Political Science* 44:635-52.

Duch, Raymond M. 2001. "A Developmental Model of Heterogeneous Economic Voting in New Democracies." *American Political Science Review* 95:895-910.

Fair, Ray C. 1978. "The Effect of Economic Events on Votes for President." *Review of Economics and Statistics* 60:159-173.

Feldman, Stanley. 1982. "Economic Self-Interest and Political Behavior." *American Journal of Political Science* 26:446-66.

Fiorina, Morris P. 1981. *Retrospective Voting in American National Elections*. New Haven: Yale University Press.

Gomez, Brad T. and J. Matthew Wilson. 2006. "Cognitive Heterogeneity and Economic Voting: A Comparative Analysis of Four Democratic Electorates." *American Journal of Political Science* 50:127-45.

Gomez, Brad T., Thomas J. Hansford, and George A. Krause. 2007. "The Republicans Should Pray for Rain: Weather, Turnout, and Voting in U.S. Presidential Elections." forthcoming, *Journal of Politics*.

Hetherington, Marc J. 1996. "The Media's Role in Forming Voters' National Economic Evaluations in 1992." *American Journal of Political Science* 40:372-95.

Inter-university Consortium for Political and Social Research. 1995. *Candidate and Constituency Statistics of Elections in the United States, 1788–1990*, ICPSR Study 7757, available at: www.icpsr.umich.edu.

Inter-university Consortium for Political and Social Research. 1995. *American National Election Studies Cumulative Data File*, ICPSR Study 8475, available at: www.icpsr.umich.edu.

Kahneman, Daniel and Amos Tversky. 1979. "Prospect Theory: An Analysis of Decision Under Risk." *Econometrica* 47:263-91.

Kramer, Gerald H. 1971. "Short Term Fluctuations in U.S. Voting Behavior, 1896–1964." *American Political Science Review* 65:131-143.

Kramer, Gerald H. 1983. "The Ecological Fallacy Revisited: Aggregate- versus Individual-level Findings on Economics and Elections, and Sociotropic Voting." *American Political Science Review* 77:92-111.

Krause, George A. 1997. "Voters, Information Heterogeneity, and the Dynamics of Aggregate Economic Expectations." *American Journal of Political Science* 41:1170-1200.

Lau, Richard R. and David O. Sears. 1981. "Cognitive Links Between Economic Grievances and Political Responses." *Political Behavior* 3:279-302.

Leip, Dave. 2006. "Atlas of U.S. Presidential Elections." accessed at http://www.uselectionatlas.org/.

Lewis-Beck, Michael S. 1983. "Economics and the French Voter: A Microanalysis." *Public Opinion Quarterly* 47:347-60.

Lewis-Beck, Michael S. and Martin Paldam. 2000. "Economic Voting: An Introduction." *Electoral Studies* 19:113-21.

MacKuen, Michael B., Robert S. Erikson, and James A. Stimson. 1992. "Peasants or Bankers? The American Electorate and the U.S. Economy." *American Political Science Review* 86:597-611.

Markus, Gregory B. 1988. "The Impact of Personal and National Economic Conditions on the Presidential Vote: A Pooled Cross-Sectional Analysis," *American Journal of Political Science* 32:137-54.

Monroe, Kristin and Lynda Erickson. 1986. "The Economy and Political Support: The Canadian Case." *Journal of Politics* 48:616-47.

National Climatic Data Center. 1994. "Time Bias Corrected Divisional Temperature-Precipitation-Drought Index." (updated since 1994), accessed at: ftp://ftp.ncdc.noaa.gov/pub/data/cirs/.

Nannestad, Peter and Martin Paldam. 1997. "The Grievance Asymmetry Revisited: A Micro Study of Economic Voting in Denmark, 1986-92." *European Journal of Political Economy* 13:81-99.

Norpoth, Helmut, Michael Lewis-Beck, and Jean-Dominique Lafay, eds. 1991. *Economics and Politics: The Calculus of Support.* Ann Arbor: University of Michigan Press.

Paldam, Martin. 1991. "How Robust is the Vote Function? A Study of Seventeen Nations over Four Decades." In *Economics and Politics: The Calculus of Support*, eds. Helmut Norpoth, Michael Lewis-Beck, and Jean-Dominique Lafay. Ann Arbor: University of Michigan Press.

Palmer, W.C. 1965. "Meteorological Drought." Research Paper No. 45, U.S. Department of Commerce Weather Bureau, Washington, D.C.

Powell, G. Bingham Jr. and Guy D. Whitten. 1993. "A Cross-National Analysis of Economic Voting: Taking Account of the Political Context." *American Journal of Political Science* 37:391-414.

Rogoff, Kenneth. 1990. "Equilibrium Political Budget Cycles." *American Economic Review* 80: 21-36.

Rogoff, Kenneth and Anne Sibert. 1988. "Elections and Macroeconomic Policy Cycles." *Review of Economic Studies* 55:1-16.

Wolfers, Justin. 2006. "Are Voters Rational? Evidence from Gubernatorial Elections." working paper, Wharton School of Business.

Wooldridge, Jeffrey M. 2003. *Econometric Analysis of Cross-Section and Panel Data.* Cambridge, MA: MIT Press.

Tables and Figures

Table 1: Description of the Palmer Drought Severity Index (PDSI)

Percent Frequency (%)	Range PDSI			Category
4%	4.00 and higher			Extreme wetness
6%	3.00	to	3.99	Severe wetness
17%	1.50	to	2.99	Mild to moderate wetness
46%	-1.49	to	1.49	Near normal
17%	-1.50	to	-2.99	Mild to moderate drought
6%	-3.00	to	-3.99	Severe drought
4%	-4.00 and lower			Extreme drought

Source: National Climatic Data Center

Table 2: Weather's Effect on State-Level Presidential Voting, 1896-2004

A. Dependent variable: Percentage of the presidential vote for the incumbent party

	All states		Farm states	
	(1)	(2)	(3)	(4)
Weather index	-.41	-1.32*	-.25	-1.21*
	(.35)	(.48)	(.35)	(.49)
Third party vote share			-.40*	-.35*
			(.05)	(.05)
Third party vote share included?	N	N	N	N
R^2	.53	.51	.55	.54
Number of observations	1328	613	1328	613

B. Dependent variable: Change in the percentage of the presidential vote for the incumbent party

	All states		Farm states	
	(1)	(2)	(3)	(4)
Weather index	-.72	-1.32*	-.60	-1.22*
	(.37)	(.46)	(.38)	(.48)
Third party vote share			-.28*	-.32*
			(.09)	(.12)
Third party vote share included?	N	N	N	N
R^2	.70	.69	.7	.71
Number of observations	1316	610	1316	610

Notes: (a) Robust standard errors are in parentheses.

(b) The regressions are weighted by the total number of votes cast in a state.

(c) All the regressions include year effects. The panel A regressions also include state fixed effects.

(d) The regressions in columns 3 and 4 include dummies for a state being a farm state.

(e) * indicates significance at the 5% level.

Table 3: Weather's Effect on Per-capita Income Growth, 1929-2005

A. All years

	National (1)	Non-farm states (2)	Farm states (3)
Weather index	-.37*	-.21	-.63*
	(.15)	(.19)	(.24)
R^2	.8	.78	.84
Number of observations	3504	1898	1606

B. 1929-1974

	National (1)	Non-farm states (2)	Farm states (3)
Weather index	-.51*	.05	-1.10*
	(.25)	(.32)	(.41)
R^2	.82	.82	.85
Number of observations	2016	1092	924

C. 1975-2005

	National (1)	Non-farm states (2)	Farm states (3)
Weather index	-.13	-.27	.03
	(.14)	(.21)	(.19)
R^2	.52	.48	.62
Number of observations	1488	806	682

Notes: (a) Robust standard errors are in parentheses.

(b) All the regressions include year effects and state fixed effects.

(c) * indicates significance at the 5% level.

Table 4: Weather's Effect on Voting Behavior Over Time, 1896-2004

Dependent variable: Change in the vote share for the incumbent party

A. All years

	National	Non-farm states	Farm states
	(1)	(2)	(3)
Weather index	-.72	.56	-1.32*
	(.37)	(.49)	(.46)
R^2	.7	.77	.69
Number of observations	1316	706	610

B. 1896-1972

	National	Non-farm states	Farm states
	(1)	(2)	(3)
Weather index	-1.01*	.89	-1.57*
	(.42)	(.5)	(.58)
R^2	.69	.78	.67
Number of observations	936	500	436

C. 1976-2004

	National	Non-farm states	Farm states
	(1)	(2)	(3)
Weather index	-.43	.23	-1.06
	(.61)	(.84)	(.71)
R^2	.71	.77	.74
Number of observations	380	206	174

Notes: (a) Robust standard errors are in parentheses.

(b) All the regressions include year effects and state fixed effects.

(c) * indicates significance at the 5% level.

Table 5: Weather's Effect on Individual Voting Behavior, 1948-2000

Dependent variable: Did a voter choose the incumbent party?

A. Logit regression results

	National (1)	Urban only (2)	Suburban only (3)	Rural only (4)
Weather index	-.04	.03	-.003	-.11*
	(.03)	(.06)	(.05)	(.05)
Pseudo-R^2	.04	.07	.05	.06
Number of observations	15966	4029	5685	5699

B. Linear regression results

	National (1)	Urban only (2)	Suburban only (3)	Rural only (4)
Weather index	-1.03	.53	.03	-2.56*
	(.64)	(1.29)	(1.1)	(1.08)
R^2	.06	.09	.07	.09
Number of observations	15969	4029	5696	5703

Notes: (a) Standard errors are in parentheses. For the linear regression results, robust standard errors are reported.

(b) The incumbent party's vote share, year effects, and state fixed effects are included in the regressions.

(c) The logit regression coefficients are reported as odds ratios.

(d) * indicates significance at the 5% level.

Table 6: Changes in Individual Voting Behavior, 1948-2000

A. Dependent variable: Did a voter change to or away from the incumbent party?

	National	Rural only
	(1)	(4)
Weather index	-1.09	-2.84*
	(0.72)	(1.20)
R^2	.042	.055
Number of observations	12689	4662

B. Dependent variable: Did a voter switch away from the incumbent party?

	National	Rural only
	(1)	(4)
Weather index	-2.32*	-3.84*
	(.83)	(1.35)
R^2	.07	.09
Number of observations	7770	2925

C. Dependent variable: Did a voter switch to the incumbent party?

	National	Rural only
	(1)	(4)
Weather index	.94	-.35
	(.95)	(1.7)
R^2	.08	.09
Number of observations	4919	1737

Notes: (a) Robust standard errors are in parentheses.

(b) The incumbent party and third party vote shares, year effects, and state fixed effects are included in the regressions.

(c) * indicates significance at the 5% level.

Table 7: Weather's Effect Over Time in Rural Areas, 1948-2000

Dependent variable: Did a voter switch away from the incumbent party?

	1948-1972	1976-2000
	(1)	(2)
Weather index	-3.42*	-.19
	(1.74)	(2.71)
R^2	.11	.10
Number of observations	1689	1236

Notes: (a) Robust standard errors are in parentheses.
(b) The incumbent party and third party vote shares, year effects, and state fixed effects are included in the regressions.
(c) * indicates significance at the 5% level.

Table 8: Testing for Asymmetries in Weather's Effect on Voting Behavior

Dependent variable: Did a voter switch away from the incumbent party?

	National		Rural only	
	(1)	(2)	(3)	(4)
Bad weather dummy	-3.19*	-2.81*	-4.93*	-4.96*
	(1.31)	(1.36)	(2.29)	(2.34)
Good weather dummy		1.71		-.15
		(1.57)		(2.50)
R^2	.07	.07	.09	.09
Number of observations	7770	7770	2925	2925

Notes: (a) Robust standard errors are in parentheses.
(b) The incumbent party and third party vote shares, year effects, and state fixed effects are included in the regressions.
(c) * indicates significance at the 5% level.

Table 9: Weather's Effect On Different Kinds of Voters, 1948-2000

Dependent variable: Did a voter switch away from the incumbent party?

A. Effect on voters with different levels of education

	All occupations		Non-farmers only	
	High school or less	College or more	High school or less	College or more
	(1)	(2)	(3)	(4)
Weather index	-2.66*	-1.41	-2.67*	-1.20
	(1.10)	(1.32)	(1.15)	(1.33)
R^2	.07	.10	.07	.10
Number of observations	4687	3029	4422	2992

B. Effect on voters of different ages

	40 and younger	Older than 40
	(1)	(2)
Weather index	-2.38	-2.12
	(1.23)	(1.13)
R^2	.07	.08
Number of observations	3670	4100

C. Effect on voters with different ideologies

	Moderate voters	Partisan voters
	(1)	(2)
Weather index	-1.28	-3.25*
	(1.39)	(0.96)
R^2	.10	.07
Number of observations	3208	4562

Notes: (a) Robust standard errors are in parentheses.

(b) The incumbent party and third party vote shares, year effects, and state fixed effects are included in the regressions.

(c) * indicates significance at the 5% level.