Does Rain Help the Republicans? Theory and Evidence on Turnout and the Vote

Author(s): Steve Knack
Source: *Public Choice*, Vol. 79, No. 1/2 (1994), pp. 187-209
Published by: Springer
Stable URL: https://www.jstor.org/stable/30026870
Accessed: 15-10-2018 21:23 UTC

Public Choice 79: 187–209, 1994.

Does rain help the Republicans? Theory and evidence on turnout and the vote

STEVE KNACK*
School of Public Affairs, American University, Washington DC 20016

Accepted 14 September 1992

Abstract. Conventional political wisdom holds that inclement weather on election day reduces turnout, and helps elect Republican candidates. Analysis of National Climatic Data Center weather records and National Election Studies (NES) survey data for 1984, 1986, and 1988 refutes the latter hypothesis: interaction variables based on various measures of partisanship and election-day rainfall show no evidence of partisan differences in the turnout-deterring impact of inclement weather. Furthermore, rainfall does not significantly reduce the probability of voting for the NES samples as a whole, but only among those respondents scoring low on the standard NES civic duty indicator.

1. Introduction

Political professionals, commentators and scholars have long believed that election-day weather conditions influence voting participation rates. Campaign coverage in nationally-distributed newspapers commonly reports weather forecasts and conditions for election day, implying a connection with turnout. On 7 November 1984, *USA Today* (p. 4A) noted of the previous day's balloting: "Record turnouts and long lines were reported at polling places across the nation. Good weather and high registration were big factors."[1] Such references are especially numerous in local newspapers in areas experiencing heavy thunderstorm activity on election day.[2] The weather pages in newspapers on election day often include editorial comments such as "a good day for voting"[3] or "a biting north wind and temperatures in the 30s and 40s in the Rockies might give some people an excuse for sitting out the election."[4]

* The author wishes to thank Joseph V. Knack (National Weather Service, ret.), William Evans, and Tancred Lidderdale for helpful comments and suggestions. American National Election Studies data were collected by the Center for Political Studies of the University of Michigan and were provided by the Inter-University Consortium for Political and Social Research. Precipitation and temperature data were collected by the National Weather Service, and provided by the National Climatic Data Center. Analyses and interpretation of the data, as well as any remaining errors, are the sole responsibility of the author.

The belief that inclement weather reduces turnout is by no means confined to non-academic sources. Various works by social scientists on voter participation and collective action take this relationship for granted (e.g., Campbell, 1960: 399; Barry, 1970: 22; Benn, 1979: 299, 303; Weisberg and Grofman, 1981: 216; Morton, 1991: 764).

A second popular belief is that in addition to affecting overall turnout rates, inclement weather also influences political outcomes. Namely, Republican candidates are thought to benefit from rain and cold temperatures. According to Radcliff and Pudaite (1991), ''a well-known adage holds that 'bad weather is Republican weather.''' Republicans' strategies often include ''praying for rain'' to diminish turnout.[5] Tucker and Vedlitz (1986: 1291) state that ''the association between high turnout and Democratic party electoral success has acquired the status of conventional wisdom in U.S. politics.'' Similarly, DeNardo (1980: 406) writes: ''Ever since the party of FDR became a majority nearly fifty years ago, the idea that a big turnout helps the Democrats has been widely accepted as a self-evident truth.'' According to *The Houston Post* on a recent rainy election day in Texas, ''... it is no secret that some candidates benefit from a large turnout while others suffer ... Democratic Gov. Mark White is hoping to hold off the gathering storm clouds just long enough to get a large turnout. His Republican challenger, former Gov. Bill Clements, will be helped by a lighter turnout'' (4 November 1986, 1A+).

Curiously, these two conventional wisdoms have apparently never been subjected to empirical analysis; with regard to its effect on turnout, everyone talks about the weather but no one ever does anything about it. This paper tests the beliefs that poor weather (a) reduces turnout, and (b) helps Republican candidates. Section 2 develops specific hypotheses. It is shown that the second of these conventional wisdoms is more complicated than it appears at first glance. Section 3 briefly describes the data and methodology used in the analysis presented in Section 4. Results are summarized, and their implications discussed, in Section 5.

2. Models of turnout and the vote

Does rain help the Republicans? The question is not as simple and innocuous as it may appear. First, what is meant by ''help''? For DeNardo (1980, 1986), ''helping'' clearly means simply increasing a candidate's expected share of the vote. Surely what many political professionals and pundits have in mind, however, is increasing the probability of a particular candidate receiving more votes than any opponent, i.e., winning. There are important differences between these two definitions.

Second, which is the ''majority party''? By some accounts, the Republicans are aided by low turnout by virtue of being in the minority. At the presidential level, there is something incongruous about a continued insistence on calling the Democratic party – losers in 5 of the last 6 contests for the White House – the majority party.

Finally, how does rainfall affect turnout? Namely, are the deterrent effects of rainfall related to any socioeconomic or political attitudinal characteristics? Close inspection of assertions of the conventional wisdom reveals that not all of its believers are employing the same implicit model. Whether or not rain aids the Republicans will be shown to depend on answers to three interrelated questions: (1) which definition of "help" is chosen, (2) which party is the "majority," and (3) which of two models describes the effects of inclement weather on turnout.

Adapting notation from DeNardo (1980), let B_d and B_r represent the fraction of eligible voters who support each party's presidential candidate, and Θ_d and Θ_r represent the fraction of supporters who actually vote. Consequently, the turnout rate can be expressed as

$$T = B_d\Theta_d + B_r\Theta_r \tag{1}$$

where $B_r\Theta_r$ ($B_d\Theta_d$) is the percentage of the eligible electorate turning out for the Republican (Democratic) candidate. Each party candidate's share of the actual vote is thus:

$$R = B_r\Theta_r/T \tag{2}$$
$$D = B_d\Theta_d/T \tag{3}$$

One version (Model I) of the argument that lower turnout favors the Republicans stresses the status of the Democrats as comprising the majority party. Columnist Tom Wicker of *The New York Times* has claimed that "a big turnout inevitably helps the majority party."[6] DeNardo (1980: 408) notes: "The idea that a heavy turnout favors the Democrats became popular during the Great Depression, after a pervasive realignment of party loyalties made the Democrats a majority party. And, according to Tucker and Vedlitz (1986: 1291): "Political practitioners and social scientists have long embraced the proposition that high voter turnout in partisan elections works to the advantage of majority party candidates."

In front-page election-day coverage, *The Houston Post* on 4 November 1986 predicted that widespread heavy rain expected in Texas would help Republican candidates: "Despite a recent trend toward realignment of Texas political parties, Democrats still hold a numerical edge. The more people who vote, the more likely the vote is to be predominantly Democratic."

DeNardo emphatically rejects this argument that heavier turnout favors the majority, showing that the expected vote shares, E(R) and E(D), remain unchanged when T increases and Θ_r equals Θ_d.[7] "It mistakenly assumes that a small voting electorate must have a different partisan coloration than a large one. If Democrats and Republicans always turn out at equal rates, however, this is not the case" (1980: 417). Model I "misses the point" by confusing "the notion of winning with the notion of helping," as the Democrats will win, in a model ignoring party defectors, regardless of whether turnout is high or low.

It is DeNardo, however, who misses the point of Wicker's implicit model, due to his narrow interpretation of "helping" as a change in expected vote share. What is of greater concern than E(R) is the probability of a Republican victory. The distinction can be crucial, as there is no monotonic relationship between E(R) and prob $(R > D)$ when T is allowed to vary.

A fall in turnout leaving E(R) and E(D) unchanged helps the minority party by increasing the *variance* of R and D. The higher variance of R and D as T falls, with Θ_r/Θ_d constant, increases prob $(R > D)$ if the Republicans are in the minority. An extreme but simple example illustrates this point. Suppose $B_d = .55$ and $B_r = .45$, and $\Theta_r = \Theta_d = 1$, so that turnout is 100% of the eligible electorate $(T = 1)$. With everyone voting, the variance of D and R are both zero, $E(D) = D = .55$ and $E(R) = R = .45$, and prob $(D > R) = 1$. On the other hand, suppose only one randomly drawn person votes, with $E(\Theta_d) = E(\Theta_r)$. Now, $E(D) = .55$ and $E(R) = .45$ as before, but prob $(D > R)$ now equals only .55, as the single voter has a 55% chance of being a Democratic supporter. Lower turnout favors the minority party in Model I not by changing E(R) and E(D), but through increasing the variance of R and D.

Notice that this model implies that lower turnout helps the minority party, regardless of whether that happens to be the Republican party. In presidential elections over the last generation, Model I predicts that an event that is equally likely to deter supporters of either major party candidate would normally *harm* the Republican candidate. Despite the edge maintained in party registration and in survey measures of party identification by the Democrats, the view of the Democratic party as being the majority party is no longer tenable in the context of presidential politics.

A second implicit model can be detected in some assertions of the conventional wisdom. Unlike Model I, the "variance" model, Model II is characterized by differential responses of Democratic and Republican supporters to rain, or other events detracting from turnout. On election day (2 November) in 1976, for example, *The New York Times* stated in a front-page story that predicted mild temperatures in much of the country "should help turn out Democratic voters."

There are several reasons why the turnout decisions of Democrats may be more responsive than those of Republicans to inclement weather. A larger percentage of Democratic supporters are thought to be "peripheral" voters, who are less interested in politics and vote only in "high-stimulus" elections involving unusually exciting campaigns or issues (Campbell, 1960; DeNardo, 1980). If the turnout decisions of these peripheral voters are heavily influenced by marginal changes in these "benefits" of voting, it is plausible that their decisions may also be sensitive to marginal changes in costs such as weather conditions. With a larger proportion of committed "core" voters who are insensitive to small or moderate changes in the net benefits of voting, the Republican vote share will rise and that of the Democrats will fall with reduced turnout.

Besides being more responsive to a given change in the costs of voting, the added costs associated with poor weather may actually be higher for Democrats than for Republicans. If Democrats are, on average, poorer, they are likely to be more reliant than Republicans on weather-sensitive modes of transport such as walking, bicycling, or walking to and waiting for a bus.

Note that the Model II implication that rain helps the Republicans is largely independent of whether they happen to comprise the majority party. Model I, the "variance" model, predicts that generalized lower turnout improves the probability of victory for the minority party candidate, while having no effect on the expected vote shares. The "differential response" model predicts rain always helps the Republican candidate in terms of expected vote share, and improves the Republican chances of winning. The Republican candidate's chances of winning could fall only if (1) Republicans are in the majority *and* (2) the gains in E(R) do not compensate for the reduction in prob $(R > D)$ associated with the increased variance of R and D as T falls. The variance effect will be minuscule, however, except in the closest of elections, and in races at local levels; even if only a few hundred thousand of the ballots cast in a presidential contest were chosen at random for counting, the sample outcome would have only a tiny probability of differing from the actual outcome, unless the vote split approached 50-50. Nevertheless, there are several grounds for taking into account a possible variance effect: (1) in extremely close elections and at local levels, it could be a significant factor in election outcomes, (2) the probability of an election outcome being affected by randomly removing a few percent of the hundred million-odd would-be presidential voters is incomparably higher than the probability of an election being decided by a single vote – an issue taken very seriously in much of the turnout literature,[8] (3) available evidence provides little support for significant partisan differences in turnout (e.g., Wolfinger and Rosenstone, 1980), so that the variance effect may be no more trivial than are any partisan effects.

Table 1 and Figure 1 contrast in summary form the hypotheses regarding the effects of inclement weather on turnout derived from the two models. With given B_d and B_r, hypotheses (1) and (2) respectively imply corollaries (3) and (4).

These hypotheses will be operationalized in terms of the probability that an

Table 1.

I. The variance model	II. The differential response model
(1) $\partial(\theta_d)/\partial P = \partial(\theta_r)/\partial P < 0$	(2) $\partial(\theta_d)/\partial P < \partial(\theta_r)/\theta P$, or $\lvert\partial(\theta_d)\theta P\rvert > \lvert\partial(\theta_r)/\partial P\rvert \geq 0$
(3) $\partial D/\partial P = \partial R/\partial P = 0$	(4) $\partial D/\partial P < 0 < \partial R/\partial P$

D,R = Vote shares of party candidates.
θ_d,θ_r = Fraction of party supporters who vote.
P = Precipitation in rainfall equivalent.

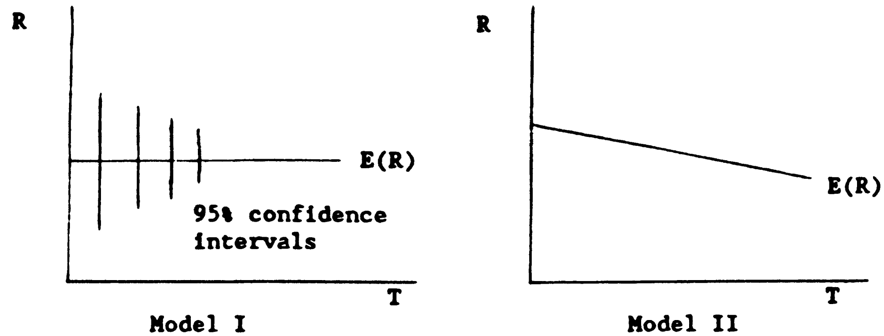

Figure 1.

individual voter will be deterred by rain from voting, controlling for other turnout-influencing variables. If Democratic supporters are more deterred than are Republican backers, then Model II is more descriptive of reality. A finding of no significant difference between supporters of the two parties would constitute evidence in favor of Model I – unless the effects of rain on both groups are zero, in which case both models are rejected.

3. Data and methodology

No single data set exists containing information on turnout, candidate preference, election-day weather conditions, and other variables influencing turnout. This study combines meteorological data published by the National Climatic Data Center with survey data from the 1984, 1986, and 1988 American National Elections Studies (NES), taking advantage of the FIPS state and county codes contained in the NES. Each respondent is tagged with rainfall and temperature data reported for weather stations in or near his city or county. Rather than self-reports or voting by respondents, turnout data are taken from the NES Vote Validation Studies, in which individual records were examined at local elections offices to determine whether or not respondents in the 1984, 1986, and 1988 surveys actually voted.

Aggregate-level studies of turnout and the vote are complicated by the issue of party "defections". In his congressional district-level study of the effects of high turnout on vote shares between 1938 and 1966, DeNardo (1980) uses party registration data to control for B_d and B_r. He finds that above-average turnout rates on balance helped – in terms of vote shares – the minority party, and attributes this result to the high number of "defectors" from the majority party among the peripheral voters who participate in high-turnout elections.[9] With NES data, one can measure directly whether the strength of rainfall's deterrent effect is associated with each of four measures: subjective party identification, party registration, pre-election candidate preference, and election day candidate preference (namely, the reported vote choice for voters, coupled with responses of nonvoters to the questions "Did you prefer one of the candidates for President?" and, if yes, "who did you prefer?"). The NES indicators of candidate preference obviate the need for modelling partisan defection – a highly problematic concept in an era when the strength of partisan identification has drastically weakened (Miller and Traugott, 1989: 81; Teixeira, 1987; Abramson and Aldrich, 1982) and large number of voters split their tickets between Republican presidential and Democratic congressional candidates. With NES data, the problem of defining and measuring defection can be bypassed by direct testing of whether rain's effect is greater for supporters of the Democratic candidate than for supporters of the Republican candidate.

In studying the effects of election-day weather conditions on turnout, the appropriate population of interest must be identified. For many citizens of voting age, the turnout decision has already been effectively made prior to election day. Most states close the voter registration rolls a week or more before the election: rain and cold on election day in these states are irrelevant for nonregistrants, who are thus deleted from the sample in this analysis. Among states represented in the 1984, 1986, and 1988 NES samples, only Minnesota, Wisconsin, and Oregon permitted voters to register on election day. As residents of these states still had the opportunity to register and vote, election-day weather conditions were potentially a relevant factor in the turnout decisions of those remaining nonregistered. Therefore, all survey respondents from these states are retained in the sample.[10]

Local weather conditions on election day are also irrelevant for absentee voters. The Census Bureau has estimated, from an item included in the 1984 CPS, that about 5 percent of ballots are cast absentee. In the 1990 NES, 5.3 percent of voters, representing 3.3 percent of registrants and 2 percent of the sample as a whole, cast absentee ballots. Unfortunately, the almost total absence of rainfall on election day in 1990 makes that year a very poor test case, and previous NES surveys did not ascertain whether respondents voted absentee or in person. A certain amount of noise is thus introduced by the inability to delete absentee voters, not to mention registered nonvoters who were out of town, in the hospital, etc. on election day. There is some reason to believe this source of error is not a serious problem, however. Approximately 9 percent of whites between the ages of 18 and 24, and over the age of 65, vote absentee, as opposed to only about 3 percent of other CPS respondents (U.S. Bureau of the Census, 1986). Eliminating these high-absentee groups from the NES samples is found to marginally *reduce* (in absolute value), rather than increase, rainfall's negative effect on turnout. Similarly, eliminating absentee voters in the 1990 NES shifts rain's insignificant but *positive* impact more strongly positive (but still insignificant).

Meteorological data for the analysis are from the Hourly Precipitation Data (HPD) and Local Climatological Data (LCD) series, published by the National Climatic Data Center. The Hourly Precipitation Data reports rainfall equivalent in inches occurring hourly at each of approximately 3000 stations with recording rain gages.[11,12] The large number of stations permits virtually all NES respondents to be matched with a station located within his or her county or metropolitan area. Where multiple stations are available in a county, the one located in the more densely populated area of the country was chosen.

Local variability in rainfall within a county or metropolitan prevents the recorded amounts from being perfect measures of conditions prevailing at a voter's home, workplace, or polling place. This problem is much less serious in November, however, when most precipitation is associated with broad frontal systems, than in the summer, when scattered thunderstorms associated with thermal convection are responsible for much of the rainfall. An informal comparison of recorded precipitation at neighboring stations within counties or metropolitan areas confirms that localized showers are not a particularly worrisome source of error.

The primary precipitation variable used in the analysis is average hourly rainfall equivalent in inches occurring during the hours the polls are open. Number of hours in which the polls are open is included in the turnout equation as a separate independent variable, as longer polling hours reduce the costs of voting by increasing the choices concerning when one can vote.

Rainfall in inches alone may sometimes be an incomplete indicator; a steady all-day rain totalling one inch of rain might inconvenience voters more than a torrential but brief downpour depositing an equal amount. The number of hours in which measurable precipitation was recorded, expressed as a percentage of the number of hours the polls are open, will thus be tested as an alternative rainfall variable.

Several temperature measures are taken from the Local Climatological Data monthly summaries, published for about 290 National Weather Service stations. Although there is an order of magnitude difference between the number of HPD and LCD stations, most NES respondents live in metropolitan areas with LCD stations. Furthermore, local variability is much less of an issue with temperature than with rainfall. An informal comparison of neighboring LCD stations suggests that a greater density of stations would add little to the accuracy of local temperature data.

A useful index of discomfort associated with temperature is "degree days," based on deviations of the daily average from 65 degrees. Using the formula $DD = 65 - (\max + \min)/2$, a positive number represents "heating degree days" (the concept was developed as an indicator of likely energy usage) while a negative number represents "cooling degree days". Heating degree days will be employed here as a measure of discomfort, since an average temperature for a November day exceeding 65 degrees is not likely to be considered unpleasant.

An alternative indicator of cold available is the maximum temperature recorded locally on election day. In most cases, the maximum occurs during polling hours, so that this value represents a limit to voters' ability to avoid the cold. For example, a low of 30 and a high of 70 degrees, and a low of 45 and a high of 55 both imply 15 heating degree days, but in the former case voters have some opportunity to avoid the cold completely.

A daily average of 50 degrees may be considered cold by Floridians but warm by Minnesotans. Heating degree days or maximum temperature will therefore be supplemented by a measure of relative coldness, departure from the normal average for the date for each station ("deviation").

Temperature variables included in a turnout model may capture otherwise unmeasured regional differences in turnout. Specifically, the hypothesized negative relationship between heating degree days and turnout could be obscured by Southerners' historic tendency to vote at below-average rates.[13] While there is some evidence that this regional gap is declining,[14] a dummy variable for residence in a southern state[15] is added to the model to ensure that the effects of temperature are not confounded with regional differences in political culture and institutions.

4. The analysis

To determine the effects of election-day weather on turnout, logit models are estimated using maximum-likelihood procedures. Non-weather variables included in the models are taken from both rational choice and "social-psychological" approaches to electoral participation.[16] (See Appendix A for coding of selected variables.)

There is disturbingly little variation in rainfall in each of the presidential

Table 2. Basic model

Variable	1984, 1988	1986
	M.L.E. (t-ratio)	
Intercept	−3.203	−3.326
	(−2.77**)	(−2.52)
College degree	1.000	1.088
	(5.16**)	(4.98**)
Some college	0.506	0.481
	(3.05**)	(2.42)
H.S. diploma	0.243	0.471
	(1.68)	(2.60)
Age in years	0.016	0.029
	(4.96**)	(7.45**)
Log of income	0.225	0.165
	(3.22**)	(1.82)
Homeowner	0.083	0.452
	(0.68)	(3.11**)
Race (black)	−0.430	−0.088
	(−2.78**)	(−0.51)
Married	0.283	0.169
	(2.52**)	(1.25)
Churchgoer	0.611	0.429
	(4.68**)	(3.35**)
Duty	0.569	–
	(5.30**)	
Care	0.588	1.009
	(5.66**)	(8.69**)
Close	0.019	–
	(0.18)	
Senate race	−0.160	−0.534
	(−1.40)	(3.97**)
Governor race	0.265	0.310
	(1.54)	(2.04*)
House contest	−0.141	−0.242
	(−1.02)	(−1.60)
South	−0.121	−0.384
	(−0.81)	(−2.11*)
Poll hours	0.043	−0.094
	(0.61)	(−1.26)
Rain average	−12.16	1.018
	(−1.32)	(0.32)
Heat. deg. days	0.012	0.003
	(1.58)	(0.24)
Deviation	0.013	0.011
	(0.95)	(0.57)
N	2980	1581
Mean dep. var.	82.2%	59.8%
Likelihood ratio index	.100	.148

* Significant at .05. ** Significant at .01.

years; both 6 November 1984 and 8 November 1988 were unusually dry days across the nation (Appendix B). Preliminary tests (not shown here) indeed found no effect of rainfall on turnout. To give the conventional wisdom a fair chance, therefore, the 1984 and 1988 data were pooled to yield a sample with hundreds of potentially wet respondents. In the basic model (Table 2, first column of regression results), rain's coefficient is negative, but is statistically significant only at the .20 level. Heating degree days is significant at the .10 level, but has the wrong sign: even with "South" controlling for regional differences, cold temperatures are, inexplicably, positively associated with turnout. Alternative models, supplementing or replacing the three main weather variables with rainfall-squared, hours of rainfall, high temperature for the day, and interaction between rain and cold corroborate the findings of weather's unimportance.

The maximum rainfall recorded for the pooled 1984–88 sample is only one-half inch. The possibility therefore remains that there is some "threshold" level of rainfall beyond which rain matters more. For a recent election day with more rainfall, one must resort to the off-year election of 4 November 1986. Measurable rainfall was recorded for 23% of NES respondents that day, with 5 stations representing 94 respondents exceeding one-half inch of precipitation (Appendix B).

Analysis of this 1986 data requires several modifications of the presidential-year model. Concern over election outcome, and election-day candidate preference, now are defined in terms of the respondent's House of Representative contest. Items on closeness and civic duty were not included in the survey that year.

Even with the highly favorable distribution of precipitation values for 1986, the effects of poor weather on the probability of voting are nil (Table 2, second column). As in the presidential-year tests, the inclusion of other weather variables fails to improve on these results. The results for 1986 suggest that if there is a threshold effect, the critical level of rainfall may be high enough that rain will rarely be a factor in turnout levels.

Furthermore, the second conventional wisdom can be even more strongly refuted: no strong or consistent partisan differences in rain's impact are found in either the presidential years (Table 3) or in the off-year election (Table 4), employing several different definitions of partisanship: interaction variables are based on pre-election candidate preference, post-election candidate preference, subjective party identification, and on party registration (the latter not shown in the tables).[17,18] One finds for the pooled 1984–88 sample that rain significantly deters Democrats, but not Republicans, *if* parties are defined by post-election preferences (Table 3, second column). When partisanship is defined in terms of subjective party identification, it is the Republicans who are significantly deterred by rain (third column). These results should be interpret-

Table 3. Partisan interaction, pooled 1984–1988

Variable	Pre-election preference	Post-election preference	Subjective party ID
	M.L.E. (t-ratio)		
Intercept	−2.342	−1.957	−2.925
	(−1.85)	(−1.46)	(−2.35*)
College degree	1.037	1.002	0.937
	(4.98**)	(4.40**)	(4.57**)
Some college	0.540	0.363	0.520
	(3.01**)	(1.88)	(2.93**)
H.S. diploma	0.287	0.109	0.271
	(1.82)	(0.63)	(1.75)
Age in years	0.016	0.019	0.015
	(4.36**)	(4.80**)	(4.22**)
Log of income	0.228	0.132	0.212
	(3.01**)	(1.63)	(2.85**)
Homeowner	0.149	0.209	0.041
	(1.12)	(1.49)	(0.31)
Race (black)	−0.588	−0.696	−0.442
	(−3.32**)	(−3.67**)	(−2.66**)
Married	0.306	0.368	0.298
	(2.53**)	(2.85**)	(2.47*)
Churchgoer	0.560	0.614	0.519
	(4.01**)	(4.08**)	(3.79**)
Duty	0.522	0.542	0.616
	(4.50**)	(4.41**)	(5.31**)
Care	0.544	0.347	0.546
	(4.71**)	(2.81**)	(4.79**)
Close	0.037	−0.096	−0.111
	(0.32)	(−0.79)	(0.96)
Senate race	−0.313	−0.355	−0.209
	(−2.48*)	(−2.65**)	(−1.71)
Governor race	0.073	0.132	0.243
	(0.39)	(0.68)	(1.32)
House contest	−0.095	−0.135	−0.078
	(−0.63)	(−0.87)	(−0.54)
South	−0.111	−0.107	−0.107
	(−0.69)	(−0.62)	(−0.67)
Poll hours	−0.024	0.037	0.053
	(−0.31)	(0.44)	(0.70)
Democrat	0.160	0.311	−0.369
	(0.71)	(1.30)	(−1.67)
Democrat *rain	−6.604	−24.278	−1.648
	(−0.52)	(−1.82)	(−0.13)
Republican *rain	−17.824	−1.329	−27.329
	(−1.20)	(−0.08)	(−1.84)

Table 3. Continued

Variable	Pre-election preference	Post-election preference	Subjective party ID
	M.L.E. (t-ratio)		
Democrat *hddays	0.013	0.022	0.020
	(1.16)	(1.80)	(2.05*)
Republican *hddays	0.016	0.013	0.008
	(1.55)	(1.27)	(0.75)
Deviation	0.006	0.022	0.011
	(0.43)	(1.48)	(0.81)
N	2646	2626	2703
Mean dep. var.	83.2%	85.4%	83.2%
LRI	.097	.100	0.098

* Significant at .05. ** Significant at .01.

ed with caution, however. Each of these party interaction terms is significant only at the .10 level. Partisanship based on pre-election preferences does not affect the strength of rain's impact (Table 3, first column). Finally, these interaction terms test only whether each group's response to rain is statistically different from zero; interaction terms designed to explicitly test the possibility that one set of partisans is significantly more deterred from voting by rain than the other set all proved insignificant.[19]

For 1986, regardless of the means of party classification, the rain coefficients are not statistically different from zero for either group (Table 4), nor were they significantly different from each other. There is some evidence in Table 4, as well as in Table 3, that it is mostly the Democrats who turn out more in cold weather.

Testing of a *non*partisan interaction variable suggests that the disappointing showing of rainfall to this point is not merely the product of measurement error or lack of sufficient variation. In Table 5, persons with low civic duty (see Appendix A for definition) are found to be significantly less likely to vote when it rains. The average decline in the probability of voting for low-duty registrants is a sizeable 3.3 percentage points for the first tenth of an inch of rainfall recorded locally.[20] The turnout decisions of high-duty registrants, in contrast, are immune to precipitation. For them, the net benefits of voting are apparently great enough that any inconveniences posed by rain are relatively trivial. Since 44% of the sample is comprised of high-duty respondents, the deterrent effects of rain on other, less committed persons is obscured in the basic model.

Strength of civic duty is the *only* variable found to affect the turnout-inhibiting power of rainfall. Interaction variables based on interest in the polit-

Table 4. Partisan interaction, 1986

Variable	Post-election preference	Subjective party ID
	M.L.E. (t-ratio)	
Intercept	−2.189	−2.462
	(−1.28)	(−1.73)
College degree	1.029	1.045
	(3.92**)	(4.52**)
Some college	0.564	0.495
	(2.33*)	(2.33*)
H.S. diploma	0.491	0.497
	(2.27*)	(2.58**)
Age in years	0.028	0.027
	(6.04**)	(6.53**)
Log of income	0.164	0.116
	(1.50)	(1.20)
Homeowner	0.432	0.489
	(2.49*)	(3.21**)
Race (black)	−0.144	−0.148
	(−0.69)	(−0.80)
Married	0.173	0.226
	(1.09)	(1.59)
Churchgoer	0.337	0.350
	(2.23*)	(2.62**)
Care	0.872	0.912
	(6.27**)	(7.38**)
Senate race	0.793	0.611
	(4.90**)	(4.26**)
Governor race	0.372	0.416
	(2.17*)	(2.61**)
House contest	−0.519	−0.273
	(−2.56**)	(−1.69)
South	−0.309	−0.385
	(−1.43)	(−2.02*)
Poll hours	−0.163	−0.120
	(−1.61)	(−1.50)
Democrat *rain	5.495	0.284
	(1.15)	(0.08)
Repuclican *rain	10.340	0.284
	(0.91)	(0.08)
Democrat *hddays	0.037	0.017
	(2.40*)	(1.33)
Republican *hddays	0.016	0.003
	(1.00)	(0.21)
Deviation	0.050	0.026
	(1.82)	(1.22)
N	1230	1416
Mean dep. var.	.678	.619
LRI	.137	.134

* Significant at .05. ** Significant at .01.

Table 5. Pooled, 1984 and 1988

	Civic duty interaction	
Variable	M.L.E.	(t-ratio)
Intercept	−3.160	−2.72**
College degree	1.012	5.22**
Some college	0.513	3.09**
H.S. diploma	0.251	1.73
Age in years	0.016	4.99**
Log of income	0.229	3.27**
Homeowner	0.084	0.69
Race (black)	−0.430	−2.78**
Married	0.284	2.53**
Churchgoer	0.607	4.65**
Duty	0.385	1.84
Care	0.589	5.66**
Close	0.019	0.18
Senate race	−0.152	−1.33
Governor's race	0.261	1.51
House contest	−0.139	−1.01
South	−0.131	−0.88
Poll hours	0.041	0.57
High duty*rain	19.298	0.98
Low duty*rain	−24.854	−2.30*
High duty*hddays	0.018	1.64
Low duty*hddays	0.009	1.03
Deviation	0.012	0.89
N	2980	
Mean dep. var.	.822	
LRI	.101	

* Significant at .05. ** Significant at .01.

ical campaign, concern over election outcome, perceived closeness, strength of partisan identification, and a measure of ongoing interest in public affairs and politics (most closely matching Campbell's, 1960, original concept of core versus peripheral voters) were also tried and found to be not significant. Similarly, lower income and rural respondents, who might be expected to be most subject to rain-related transportation difficulties, are no more deterred from voting than are high income and urban respondents.

That rain's impact is independent of all demographic and attitudinal variables, with the exception of civic duty, provides insight into the lack of partisan differentials in impact. Although other variables distinguishing "peripheral" from "core" voters may be correlated with partisanship, civic duty is not. The statistically insignificant difference in the pooled 1984–1988 sample in fact

Table 6. 1984–1988 variables

Variable	Mean	S.D.
College degree	0.221	0.415
Some college	0.258	0.438
H.S. diploma	0.338	0.473
Age in years	46.0	17.33
Log of income	9.93	0.879
Homeowner	0.714	0.452
Race (black)	0.104	0.306
Married	0.620	0.486
Churchgoer	0.275	0.467
Duty	0.444	0.497
Close	0.360	0.480
Care	0.683	0.465
Senate race	0.647	0.478
Governor race	0.118	0.323
House contest	0.828	0.377
South	0.312	0.464
Poll hours	12.85	0.898

favors the Democrats: 45.4% of Democratic party identifiers are classified as high-duty, versus 43.3% for Republican identifiers, while 47.5% of the respondents indicating an election-day preference for the Democratic candidate are high duty, versus only 43.6% of Republican supporters.

5. Conclusion

Rain can be said to deter peripheral voters, with the caveat that ''periphery'' and ''core'' are defined in terms of strength of civic duty to vote, rather than in terms of interest in politics. At least by this duty-based definition, Democratic candidates are *not* disproportionately reliant on peripheral voters, so there is no partisan differential impact of inclement weather; i.e., Model II can be confidently rejected.

Model I is the only model of turnout and the vote with any applicability to the case of inclement weather. To the extent rain keeps some low-duty registrants away from the polls, Model I receives some empirical support. With a few less voters, election outcomes are marginally less predictable, with the probability of an upset growing slightly. It is not the Republican candidate, but rather the candidate trailing in the election-eve polls – almost invariably a Democrat in presidential contests of the last generation – who should be praying for rain.

The results of this analysis of weather and turnout have more general relevance for the study of voter participation. The importance of social norms as a major source of "benefits" from voting receives added support.[21] Strength of civic duty – not income, or urban-rural differences – determines the impact of rain on turnout. High-duty voters are immune to costs associated with bad weather. Among non-meteorological variables in the model, other benefits proxies such as perceived closeness and the presence of other races on the ballot perform surprisingly poorly. A Senate race on the ballot increases turnout only in the off-year election of 1986, when control of the Senate reverted to the Democrats. Regular church attendance, on the other hand, has as large an impact on turnout in 1984 and 1988 as concern over the election outcome.[22] The performance of the social norms variables relative to the "instrumental" benefits variables is particularly impressive given that it is only the second stage of the turnout decision that is examined here. The effects of election-specific variables such as closeness and the presence of other races on the ballot should arguably show up primarily at this second stage of the turnout decision.

Finally, the modest explanatory power of the turnout models considered here further illustrates the difficulty of accounting for who, among persons registered to vote, actually votes in the election (e.g., see Erikson, 1981). Our present ability to predict who, among voting age citizens, votes is largely a result of our ability to predict who registers.[23] Data on transitory factors such as illness on election day, or on voter-mobilizing activities of parties and candidates (Caldeira and Patterson, 1982), would seem to promise an improvement in the ability to predict turnout among registrants. However, the present analysis of one of these transitory factors – election-day weather conditions – leaves the second stage of the turnout decision largely a mystery.

Notes

1. Also see *The New York Times*, 2 November 1976, p. 1+; and 3 November 1976, p. 1+; and *The Washington Post*, 7 November 1990, A27. All newspaper citations are final editions unless otherwise indicated.
2. E.g., see *The Dallas Morning News*, 4 November 1986, 1A+, 15A+; and 5 November 1986, 1A+, 21A+ (early edition); and *The Houston Post*, 4 November 1986, 1A+.
3. *USA Today*, 5 November 1984, 14A.
4. *USA Today*, 2 November 1982, 12A. Also see *The New York Times*, 2 November 1976, p. 57; and 3 November 1976, p. 82.
5. For instance, see Hadley (1978: 109); and *The Washington Post*, 4 November 1976, C1+.
6. *The New York Times*, 29 October 1976, Op. Ed. page; cited in DeNardo (1980).
7. More generally, all that this result of DeNardo's requires is that Θ_r/Θ_d is unchanged when T changes.
8. For examples of theoretical papers, see Palfrey and Rosenthal (1983), and Ledyard (1981,1984). For representative empirical papers, see Jackman (1987), Durden and Gaynor (1987), and Cebula and Murphy (1980).

9. Tucker and Vedlitz (1986) attempt to refute DeNardo's result on the basis of 1932–1980 state-level data, finding that Democrats win a disproportionate number of states and electoral votes in high-turnout elections. Given their differing definition of "help", their result is not necessarily inconsistent with DeNardo's.

   More recently, Radcliff and Pudaite (1991), using 1932–1980 state-level data, have refuted DeNardo on his own turf, showing that even in terms of expected vote share higher turnout favors the Democrats.
10. Oregon voted on 4 November 1986, to establish a 21-day registration closing date requirement, to take effect before the next election. Accordingly, Oregonian nonregistrants are deleted from the 1988 sample.
11. The exact number of stations varies as stations are added or deleted from time to time.
12. There was virtually no snowfall on election day at any of the reporting stations, so no attempt is made here to distinguish the effects of snow from those of rain.
13. The correlation coefficient for South and heating degree days for the three NES samples (pooled) is −.519, significant at .0001.
14. Southern residence consistently decreased the probability of voting in presidential elections throughout the 1960s and 1970s (Reiter, 1979), and in off-year elections through the 1970s (Conway, 1981). Boyd (1986), however, finds a positive (but insignificant) effect for South in the 1980 election. Also see Wolfinger and Rosenstone (1980: 93–94).
15. As defined by the Census Bureau, the South includes AL, AR, DE, DC, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA, WV.
16. See Riker and Ordeshook (1968) and Durden and Gaynor (1987) for examples of the former, and Wolfinger and Rosenstone (1980) and Teixeira (1987) for examples of the latter.
17. Party registration is available only in the 1984 NES survey; pre-election candidate preference is not available for 1986, when no pre-election wave was conducted by the NES.
18. Independents are deleted from interaction models based on party identification and registration, and undecideds are deleted from interaction models based on candidate preference.
19. Results available on request from author.
20. This figure is obtained by summing the changes in predicted probabilities associated with .10 inches of rainfall for each low-duty individual, and dividing by the number of low-duty respondents. The relevant equation is

$$P - P^* = 1/(1+e^{-BX_i}) - 1/(1+e^{-BX_i^*}) = .782 - 749$$

   where P and P* are obtained from a model including only low-duty respondents, with "rain avg." set equal to 0 in BX_i and equal to .10/polling hours in BX_i^*.

   The marginal impact of precipitation gradually rises with greater amounts of rain in the model, with the probability of voting dropping by 3.5 percentage points for the second tenth of an inch, and 3.9 points for the third. This pattern in the simulation results is merely an inevitable consequence of using the logit model. The slope of the cumulative logistic function is maximized at P = .5, so that the impact of a given change in any independent variable increases as the probability of voting approaches 50 percent.
21. Given the limited efficacy of an individual vote, private benefits such as satisfying one's sense of civic obligation *should* matter more than "public" benefits relating to election outcomes, if citizens are rational and self-interested. See Knack (1992) for more extensive theory and evidence on this issue.
22. For analyses of the relationships among church involvement, civic duty, and voter turnout, see Strate et al. (1989), and Macaluso and Wanat (1979).
23. Knack (1991) identifies a significant cost associated with registering to vote in most jurisdictions that had previously been neglected in the turnout literature.

References

Abramson, P.R. and Aldrich, J.H. (1982). The decline of electoral participation in America. *American Political Science Review* 76: 502–521.

Barry, B. (1970). *Sociologists, economists, and democracy*. London: Collier-Macmillan.

Benn, S. (1979). The problematic rationality of political participation. In P. Laslett and J. Fishkin (Eds.) *Philosophy, politics, and society*. New Haven: Yale University Press.

Boyd, R.W. (1986). Election calendars and voter turnout. *American Politics Quarterly* 14: 89–104.

Caldeira, G.A. and Patterson, S.C. (1982). Contextual influences on participation in U.S. state legislative elections. *Legislative Studies Quarterly* 7: 359–381.

Campbell, A. (1960). Surge and decline: A study of electoral change. *Public Opinion Quarterly* 24: 397–418.

Cebula, R.J. and Murphy, D.R. (1980). The Electoral College and voter participation rates: An explanatory note. *Public Choice* 35: 185–190.

Conway, M.M. (1981). Political participation in midterm congressional elections: Attitudinal and social characteristics during the 1970s. *American Politics Quarterly* 9: 221–244.

Council of State Governments (1984–90). *The book of the states* (Vols. 25–28). Council of State Governments, Lexington, Kentucky.

DeNardo, J. (1980). Turnout and the vote: The joke's on the Democrats. *American Political Science Review* 74: 406–420.

DeNardo, J. (1986). Does heavy turnout help Democrats in presidential elections? (reply to Tucker and Vedlitz) *American Political Science Review* 80: 1298–1304.

Durden, G.C. and Gaynor, P. (1987). The rational behavior theory of voter participation: Evidence from the 1970 and 1982 elections. *Public Choice* 53: 231–242.

Erikson, R.S. (1981). Why do people vote? Because they are registered. *American Politics Quarterly* 9: 259–276.

Hadley, A.T. (1978). *The empty polling booth*. Englewood Cliffs, NJ: Prentice-Hall.

Jackman, R.W. (1987). Political institutions and voter turnout in the industrial democracies. *American Political Science Review* 81: 405–423.

Knack, S. (1993). The voter participation effects of selecting jurors from registration lists. *Journal of Law and Economics* (forthcoming).

Knack, S. (1992). Civic norms, social sanctions, and voter turnout. *Rationality and Society* 4(2): 133–156.

Ledyard, J.O. (1981). The paradox of voting and candidate competition: A general equilibrium analysis. In G. Horwich and J.P. Quirk (Eds.), *Essays in contemporary fields of economics*. West Lafayette, In: Purdue University Press.

Ledyard, J.O. (1984). The pure theory of large two-candidate elections. *Public Choice* 44: 7–41.

Macaluso, T.F. and Wanat, J. (1979). Voting turnout and religiosity. *Polity* 12: 158–169.

Miller, W.E. and Traugott, S. (1989). *American national election studies data sourcebook, 1952–1986*. Cambridge: Harvard University Press.

Morton, R.M. (1991). Groups in rational turnout models. *American Journal of Political Science* 35: 758–776.

NOAA/National Climatic Data Center. *Hourly precipitation data* Nov. 1990, Nov. 1988, Nov. 1986, Nov. 1984. Asheville, NC: U.S. Dept. of Commerce.

NOAA/National Climatic Data Center. *Local climatological data, monthly summaries* Nov. 1988, Nov. 1986, Nov. 1984. Ashville, NC: U.S. Dept. of Commerce.

Palfrey, T. and Rosenthal, H. (1983). A strategic calculus of voting. *Public Choice* 41: 7–53.

Radcliff, B. and Pudaite, P. (1991, August). The majority party and turnout: A critique and reinterpretation. Mimeo. Paper presented at the Meeting of the American Political Science Association annual meeting in Washington, DC.

Reiter, H.L. (1979). Why is turnout down? *Public Opinion Quarterly* 43: 297–311.
Riker, W. and Ordeshook, P. (1968). A theory of the calculus of voting. *American Political Science Review* 62: 25–42.
Strate, J.M. et al. (1989). Life span civic development and voting participation. *American Political Science Review* 83: 443–464.
Teixeira, R. (1987). *Why Americans don't vote: Turnout decline in the United States, 1960–1984.* Westport, CT: Greenwood Press.
Tucker, H.J. and Vedlitz, A. (1986). Does heavy turnout help Democrats in presidential elections? *American Political Science Review* 80: 1291–1298.
U.S. Bureau of the Census. (1986). *Voting and registration in the election of November 1984.* Current Population Reports, Series P-20, No. 405. Washington, DC: U.S. Government Printing Office.
Weisberg, H.F. and Grofman, B. (1981). Candidate evaluations and turnout. *American Politics Quarterly* 9: 197–219.
Wolfinger, R.E. and Rosenstone, S.J. (1980). *Who votes?* New Haven: Yale University Press.

Appendix A

Coding of selected variables

Age: Actual age in years.
Race: If black = 1, else = 0.

Education
Degree: If respondent has a college degree = 1, else = 0.
Some coll.: If respondent has more than 12 years of schooling but no college degree = 1, else = 0.
Diploma: If respondent graduated from high school or passed an equivalency test, but has no further schooling = 1, else = 0.

Log Income: Respondents chose the category (out of 23) containing their estimated household income for the previous year. The log of the midpoint of the respondent's category was taken. In the pooled 1984–1988 sample, "real" income is used: the 1988 midpoints were adjusted for inflation to be compatible with the 1984 figures.

Churchgoer: if respondent attends church or synagogue every week = 1, else = 0.

Close: If respondent expects the Presidential race to be closely contested both nationally and in here state = 1, else = 0.

Polling hours: number of hours the polls are open on election day in respondent's state or county (sources: Council of State Governments, 1990, 1988, 1986, 1984; and state election administrators).

Care about election outcome: If respondent cares "a good deal which party wins the presidential election" = 1; if respondent doesn't "care very much which party wins" = 0.

Civic Duty to vote: If respondent indicates disagreement with the statement: "if a person doesn't care how an election comes out, then that person shouldn't vote in it," duty = 1; if respondent agrees, duty = 0. In the 1988 survey, there were five possible responses; "disagree somewhat" and "disagree strongly" are coded as duty = 1, with "neither agree or disagree" coded as duty = 0 along with "agree somewhat" and "agree strongly". Results are not sensitive, however, to whether the middle category is coded high-duty or low-duty.

South: Census definition, which includes DC, DE, KY, MD, and WV in addition to the former Confederate states. Results are not sensitive to whether the Census definition or the Confederacy definition is used.

Appendix B

Table B1. Summary of weather conditions, NES Sample (N = 1779), 1984

6 November 1984

Rainfall

Inches	N	%	Hours	N	%
0.00	1663	93.5%	0	1663	93.5%
0.01	25	1.4	1	25	1.4
0.07	13	0.7	2	13	0.7
0.28	23	1.3	4	23	1.3
0.37	55	3.1	5	55	3.1

Temperature

Heating degree days	N	%	Deviation from normal average	N	%
0	163	9.2%	+10	29	1.6%
3	94	5.3	+9	55	3.1
5	45	2.5	+6	17	1.0
6	101	5.7	+5	67	3.8
7	32	1.8	+3	202	11.4
8	83	4.7	+2	88	4.9
10	35	2.0	+1	139	7.8
14	83	4.7	0	237	13.3
15	76	4.3	−1	55	3.1
16	229	12.9	−2	5	0.3
17	79	4.4	−3	156	8.8
18	32	1.8	−4	223	12.5
19	93	5.2	−5	93	5.2
20	33	1.9	−6	289	16.2
21	5	0.3	−8	124	7.0
22	33	1.9			
26	192	10.8			
27	177	9.9			
28	90	5.1			
29	104	5.8			

Table B2. Summary of weather conditions, NES Sample (N = 1444), 1988

8 November 1988

Rainfall

Inches	N	%
0.00	1255	86.9%
0.01	59	4.1
0.02	29	2.0
0.05	16	1.1
0.10	36	2.5
0.17	27	1.9
0.25	20	1.4
0.50	2	0.1

Hours	N	%
0	1255	86.9%
1	125	8.7
3	15	1.0
4	2	0.1
5	47	3.3

Temperature

Heating degree days	N	%
0	95	6.6%
2	30	2.1
3	36	2.5
4	126	8.7
6	22	1.5
7	29	2.0
8	55	3.8
9	64	4.4
11	7	0.5
12	38	2.6
13	55	3.8
14	31	2.1
15	41	2.8
16	41	2.8
17	72	5.0
18	32	2.2
19	69	4.8
20	34	2.4
21	59	4.1
22	107	7.4
23	189	13.1
25	53	3.7
26	57	3.9
27	64	4.4
29	38	2.6

Deviation from normal average	N	%
+18	33	2.3%
+12	30	2.1
+10	29	2.0
+8	36	2.5
+6	39	2.7
+5	28	1.9
+4	60	4.2
+3	31	2.1
+2	147	10.2
+1	275	19.0
0	162	11.2
−1	346	24.0
−2	44	3.0
−3	89	6.2
−5	57	3.9
−6	38	2.6

Table B3. Summary of weather condition for NES Sample (N = 1624), 1986

4 November 1986

Rainfall

Inches	N	%	Hours	N	%
0.00	1251	77.0%	0	1251	77.0%
0.01	94	5.8	1	141	8.7
0.02	19	1.2	1.5	7	0.4
0.06	34	2.1	2	30	1.8
0.08	26	1.6	3	29	1.8
0.10	43	2.6	4	64	3.9
0.12	27	1.7	5	46	2.8
0.20	14	0.9	6	39	2.4
0.24	17	1.0	7	17	1.0
0.34	5	0.3			
0.59	15	0.9			
0.70	18	1.1			
0.90	21	1.3			
1.28	19	1.2			
1.30	21	1.3			

Temperature

Heating degree days	N	%	Deviation from normal average	N	%
0	320	19.7%	+17	21	1.3%
2	47	2.9	+11	18	1.1
3	71	4.4	+10	48	3.0
5	20	1.2	+8	19	1.2
6	34	2.1	+7	72	4.4
7	71	4.4	+6	77	4.7
8	35	2.2	+5	141	8.7
11	45	2.8	+4	93	5.7
13	40	2.5	+3	132	8.1
14	65	4.0	+2	59	3.6
15	60	3.7	+1	71	4.4
17	67	4.1	0	126	7.8
19	7	0.4	−1	102	6.3
20	37	2.3	−2	108	6.7
22	259	15.9	−3	66	4.1
23	66	4.1	−4	126	7.8
24	47	2.9	−5	130	8.0
25	25	1.5	−6	59	3.6
26	82	5.0	−7	87	5.4
27	62	3.8	−8	43	2.6
28	29	1.8	−10	26	1.6
29	32	2.0			
30	43	2.6			
32	29	1.8			
33	31	1.9			