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Notes on recent elections

# Does Election Day weather affect voter turnout? Evidence from Swedish elections

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ABSTRACT

Does rainfall during the Election Day reduce voter turnout? Previous research shows that in the US one inch of rain reduces turnout with about one percentage point. We turn to the Swedish context in order to test whether rainfall on Election Day have the same impact in a high turnout context. We move beyond previous research by testing the impact of GIS-interpolated rainfall on three different datasets that allows us to view the issue both from a wide time frame as well as with high precision as for turnout measures: (a) aggregate turnout data for Sweden's 290 municipalities, (b) individual level data from the Swedish National Election Study and (c) data from a register-based survey on voter turnout. In none of the three datasets do we find robust negative effects of rain.



In this research note we investigate whether rainfall during the Election Day reduces voter turnout. According to widespread belief, expressed in news media and among academics, rainfall on Election Day is expected to lower voter turnout (Franklin, 2004; The New York Times, 2006; Washington Post, 2008). However, only a handful of studies provide solid empirical evidence to support this claim (Gomez et al., 2007a; Knack, 1994; Gatrell and Bierly, 2002). In the most sophisticated analysis to date, Gomez, Hansford and Krause (henceforth GHK) find a negative effect of rain. They show that one inch of rain reduces turnout with about one percentage point in presidential elections in the US, i.e. a small, but statistically significant effect.

The underlying assumption for the hypothesis that rainfall decreases turnout is that voters assess the costs and benefits associated with voting. If the benefits outweigh the costs, individuals will cast their votes, and if not, they will abstain (Wolfinger and Rosenstone, 1980; Aldrich, 1993). However, the studies on the impact of rain during Election Day mentioned above all investigate turnout in the US (Gomez et al., 2007a; Knack, 1994; Gatrell and Bierly, 2002), a country where, in a comparative perspective, the costs associated with voting are high (even when it does not rain) (Powell, 1986). Moreover, the first past the post electoral system make it extremely improbable that a single vote will affect the outcome in many states. Hence, ambiguity surrounds the generalizability of these findings: can the negative effects of rain on voter turnout also be found in other contexts where the costs of voting are substantially lower, and the benefits of voting are higher?

In an attempt to answer this question we turn to such a context: Sweden. Hence, the study makes it possible to compare the effect of a small increase in voting costs, i.e. rain, in different cultural contexts. Within the group of industrialized western countries, the Swedish electoral system is in many crucial aspects different from the one in the US. Also, the turnout levels are consistently much higher in Sweden (between 80 and 92 percent between 1976 and 2010).

To set up the test as rigorously as possible, we test the impact of rainfall using three different datasets. We use

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data on aggregate levels of turnout, which mimic as closely as possible the research design employed by GHK, to test the generalizability of their findings. In addition, we also present results from two individual-level datasets covering more than 150,000 individuals as additional checks on the robustness of the findings. The amount of rainfall in each of the 290 municipalities of Sweden is estimated by means of Geographic Information System (GIS) interpolation of data from the Swedish Meteorological and Hydrological Institute, stemming from about 750 whether stations in all of Sweden's 290 municipalities during the period 1976–2010. We then estimate the effects of rainfall on turnout levels at both municipal and individual levels.

In none of the three datasets do we find robust negative effects of rain. The main contribution of this study is that the negative effects of additional costs of voting such as rain during Election Day found in US studies do not seem to be generalizable to a context where the overall costs of voting are lower and the benefits of voting are higher. We do not test the effects of costs and benefits directly, but since it is found that the effect of rain on voting varies between Sweden and the US we suggest that the most reasonable theoretical explanation is the different levels of costs and benefits of voting in the two countries. This finding is of importance not only to those interested in explaining why people turn out to vote, but also because Election Day weather is one of the few, and perhaps the most frequently used, instrumental variable for voter turnout (Hansford and Gomez, 2010). Hence, since the results suggest that the effect of Election Day weather differs between contexts such as Sweden and the US, caution should exercised before using it as an instrumental variable in other contexts.

## 1. The costs and benefits of voting

In the rational choice model of voting, each voter is assumed to calculate the costs and benefits associated with casting a ballot (Aldrich, 1993; Blais, 2000, 2006). According to this theory, voters will cast their votes if the expected benefits outweigh the costs. When reducing the costs of voting by making the process of casting a vote more convenient, voter turnout generally increases, and vice versa. For example, factors which decrease the costs of voting such as possibilities for early voting, or holding elections on Saturdays and Sundays tend to increase turnout (Gronke et al., 2007; Franklin, 2004). On the other hand, factors increasing the costs of voting, such as a long distance to the voting booth or changes of the location of the polling station decrease turnout (Dyck and Gimpel, 2005; Brady and McNulty, 2011; Gimpel and Schuknecht, 2003.

Only a few previous studies evaluate the impact of rain empirically and these studies show contradictory results. Knack uses individual level data from the American National Election Studies conducted in 1984, 1986 and 1988 to gauge the effects of rain on turnout (Knack, 1994). Knack finds no overall effects of rain on turnout, but a negative effect among those with low sense of civic duty. However, significant negative main effects are found by Shachar and Nalebuff (1999), Eisinga et al. (2012), Gatrell and Bierly (2002) and Gomez et al. (2007a) The study by GHK is the most sophisticated to date: They use GIS-interpolated weather data from over 20,000 weather stations for 14 US presidential elections (1948–2000). Since they employ a panel data design including 3115 counties in 14 elections they get 43,340 observations and thus have substantial variation in levels of rain and turnout. However, the estimated effect of rain in the study by GHK is very small: one inch of rain during election day, which implies heavy downpour, is only expected to reduce turnout by 0.83 percentage points. When they include county fixed effects, the effect of one inch rain is amplified to a decrease in turnout with 0.98 percentage points (Gomez et al., 2007b). Moreover they find that rain increases the vote shares for republicans (as a consequence of voter turnout among democrats presumably being more easily negatively affected by additional costs of voting). According to GHK the weather may have affected the outcomes of the presidential elections in 1960 and 2000.

Moreover, in a US study by Fraga and Hersh (2010) it is tested whether Election Day rainfall has the same effect in competitive elections as in uncompetitive elections. Fraga and Hersh show that in competitive states where stakes are high, Election Day rainfall has no substantive impact. However, in uncompetitive states where the benefits of voting are lower, it is more likely that a small additional cost will tip the scales against voting.

## 2. The swedish context

The Swedish election system is based on proportional representation. Every four years (every three years until 1994), elections are held on the same day to the national parliament (the Riksdag), the regional parliaments and the local parliaments. The party lists are closed but voters are allowed to cast a personal vote for a candidate on the party list. A special version of the Sainte-Laguë method in which the first divisor is replaced by 1.4 is utilised to count the votes. Compared to the standard Sainte-Laguë method, the Swedish version gives a slight benefit to large parties. Sweden is divided into 29 constituencies. The national parliament has 349 seats, 310 of them are permanent seats distributed by constituencies on the basis of their population entitled to vote, while the remaining 39 are adjustment seats, which are there to secure proportionality. There is a four per cent threshold which parties have to exceed in order to get representation in the parliament. We should keep in mind that most previous studies on rain and voting have been conducted in a very different context: US presidential elections. The cost of voting is higher in the US since, for example, voters need to register in order to be able to vote and the likelihood that a vote should be pivotal is most often lower since all states apply a winner-takes-all rule when deciding on the votes in the electoral college.

In a comparative perspective voter turnout is relatively high in Sweden. During the last five decades the highest level of turnout in Swedish parliamentary elections was 92 percent (1976), while the lowest level was 80 percent (2002). The decline in turnout during the last decades has been weaker in Sweden than among Western democracies in general. Since 2002 voter turnout has increased slightly in Sweden (Persson et al., 2013).

We hypothesize that the effect of rain on turnout is likely to be smaller in Sweden than in the US, as the costs of voting are lower and the benefits of voting are likely to be perceived as higher in Sweden. There are several aspects of the Swedish voting context that needs to be highlighted in this respect, most importantly: weekend voting, the electoral system and the level of turnout.

First, the Election Day in Sweden is always the third Sunday in September, while it is always is the first Tuesday after the first Monday in November in the US. In fact, the rationale behind the decision to place the Swedish elections in September was that the whole country is free from snow and the harvest is reaped (Oscarsson and Holmberg, 2004). It is reasonable to expect that the costs of voting decrease substantially if the election takes place on a day when most people do not work rather than a weekday, as voting on a workday takes up a larger portion of the time for leisure (cf. Franklin, 2004). Hence, voting on a weekend as in Sweden makes the costs of voting lower.

Second, the Swedish system is, in contrast to the American majoritarian system, proportional. Several studies have shown that, at least in Europe, turnout is higher in proportional systems (Blais and Arts, 2006), and it is more likely that a vote will be decisive in a proportional system. In contrast, supporters of the smaller party in the US states that are not seen as "battlegrounds" are likely to feel that their vote is extremely unlikely to affect the outcome. For example, California, the most populous state, has in the last six presidential elections been won by the Democratic candidate, in five of them with a double-digit margin of victory. The Republican candidate has instead won Texas, the second most populous state, all six elections, four of them with double-digit margins.

Third, in Sweden, citizens do not need to register in order to be eligible to vote. Every Swedish citizen get their voting card sent home by mail and do only need to bring that card and a photo id to the polling station in order to vote. (In fact, since 2010 one does not even need to bring the registration card but only a photo id to the polling station.) Moreover, voters have very generous possibilities to vote early (one can vote early about three weeks before the election day at libraries and other public places). In the US, most states apply registration laws of different kinds. Previous research agrees on the fact that registration laws increase the costs of voting and thereby decrease turnout (Highton, 1997; Wolfinger and Rosenstone, 1980).

Furthermore, the generally high turnout levels in Sweden may in itself contribute to increasing the benefits of voting, or the costs of not voting. When many people around you vote, you might feel a social pressure to do it yourself. In a massive field experiment, Gerber et al. (2008) found that applying social pressure in the form of information of whether neighbors voted or not, had a sizeable and significant effect on the likelihood of voting. Other experimental studies have found that individuals' propensity to vote affects other members of the same household, and that messages emphasizing that turnout is going to be high are more effective than messages warning that turnout might be low (Nickerson, 2008; Gerber and Rogers, 2009).

Moreover, in Sweden voters have many possibilities to vote early (one can vote early about three weeks before the election day at libraries and other public places), which reduces the chance that rain on one day will deter people from voting. In the US, steps have been taken during recent years to relax the requirements for absentee balloting (Gronke, 2008), but on average the possibilities for early voting are still larger in Sweden. Taken together, the costs of voting seem to be higher in the US, and the perceived benefits lower.[3] We therefore hypothesize that the effect of rain on turnout is smaller in Sweden than in the US.

## 3. Methods and data

Our empirical strategy is to use three datasets with different strengths and weaknesses to triangulate the true effect of Election Day rainfall on turnout. In all datasets, the elections in focus are elections to the *Riksdag* (the parliament). First, we use panel data on turnout levels from the 290 municipalities in Sweden from 1976 to 2010, totaling 3128 observations in 11 elections. At the municipality level the lowest level of turnout in our dataset is 67 percent and the highest level is 96 percent. We use the officially reported election results from Statistics Sweden.

Following GHK, we control for a number of municipal level factors in our models. More precisely we include controls for *population size* (*ln*), *area size* (*ln*) and *percentage of immigrants* (*ln*). We also include a control for the turnout level at the previous election. This set of controls is considerably smaller than the set of controls used by GHK, but still captures important dimensions in the variation between municipalities, as population size and area correlates with other important demographic variables such as average income and education levels. The reason why we do not include an identical set of controls is that some variables are not applicable in the Swedish context. In addition, the data is unavailable for some of the variables for earlier years in the sample.

GHK control for four forms of registration requirements and such controls are unnecessary in the Swedish case since no registration is needed in order to vote. They also include controls for percentage of high school graduates, median income and percentage of African Americans. While we control for percentage of immigrants (who, as African Americans in the US context, generally vote to a lesser extent) data on mean educational levels and median income in municipalities are unfortunately unavailable. However, the lagged dependent variable obviously accounts for a large amount of the unobserved factors influencing municipality level turnout. Despite the lack of data on some of the socioeconomic factors, our models resemble GHK's models as closely as possible. Moreover, we also use a second estimation strategy where we include

[3] It should be emphasized that costs and benefits are of course not the only factors that determine the decision to vote. Voting can also be influenced by factors that have less to do with costs and benefits; voting as a habit, voting as a result of a sense of civic duty or social network mobilization.

municipality fixed effects in the model, which controls for all the between-municipality variation. Together with the inclusion of the lagged dependent variable, the model accounts for virtually all unobserved factors. In order for the coefficient of rainfall to be biased, rainfall on election day would have to correlate with changes in the levels of unobserved factors in the municipality since the last election, which is highly unlikely.

The drawback of this approach is that while the rational choice model of voting concerns mechanisms at the individual level, we measure behavior at the aggregate level, thereby possibly running into problems of ecological inference. GHK justify their method by claiming that they are interested only in aggregate turnout levels, but while that may be true, the investigated causal mechanism is undoubtedly located at the individual level.

To alleviate this problem, we also analyze survey data from the Swedish National Election Studies. The data consists of between two and three thousand respondents in a nationally representative sample, who were interviewed in each of the five elections from 1991 to 2006. The voter turnout variable has been validated against official records. Respondents were also asked about their level of political interest, which allows us to investigate the interaction between political interest and rain. However, while several thousands of respondents may seem as a large number at first, we have to bear in mind that the expected effect of rain is very small. If the effect of rain on voter turnout in Sweden is of the same magnitude as GHK's estimate, we should expect about one percent of potential voters to refrain from voting, in the case of extremely heavy rain. If a tenth of the voters experienced one inch of rain on Election Day (a somewhat extreme assumption), we should only expect one individual out of every thousand voters to abstain because of rain. In this light, a dataset with 10,000 observations does not seem entirely adequate to capture the effects.

Therefore, a final dataset is utilized: Statistics Sweden's register-based survey of voter turnout. The survey is based on samples from the Labor Force Survey (LFS) and additional samples from population groups not covered in the LFS, e.g. elderly. Information about whether the individuals included in the samples voted or not is gathered from official electoral registers. This data on turnout for a very large representative sample is combined with other registry data on socioeconomic indicators, such as age, gender, education and income. The fact that the survey is based on a stratified sampled with unequal inclusion probabilities has been taken into account while analyzing the data. With a number of observations of almost 140,000, we are well equipped to measure even very small effects of rain. Since the data is mainly register data, we do not have any indicator on political interest or sense of civic duty. However, we can estimate the interaction of rainfall with socio-economic factors, such as the level of educational attainment. From both of the individual-level datasets, we exclude individuals who voted before Election Day, and thus cannot have been affected by Election Day precipitation. GHK's dependent variable does not take this into account, and their estimate should therefore be seen as conservative.

We obtained data of rainfall during the election days from the Swedish Meteorological and Hydrological Institute (SMHI). The raw data includes observations from 700 to 800 weather stations in Sweden per election. To get as valid measures of weather conditions as possible we make use of GIS interpolations. Using a surface grid we mapped the weather station data and calculated interpolated measures of weather with Universal Kriging with linear drift. This interpolation allows us to estimate the rainfall in the areas between observation stations. Municipal boundaries were then mapped to the grid, and average levels of rainfall were then calculated. This method of estimating rainfall is similar to the one used by GHK. Election dummy variables are included in all models.

The highest mean level of rain in our dataset is from 1985 when 0.140 inch of rain fell during the Election Day. The least rain was measured in 1976, when on average only 0.001 inch of rain fell. Obviously, the levels of rain also differ considerably between municipalities within election years. Fig. 1 displays histograms for rainfall in the municipalities all years (left panel) and for the year with maximum average rainfall, 1985 (right panel). The highest estimated level of rain in our data is 0.660 inches (Haparanda municipality in 1985).[4]

The range of rainfall is lower in our sample than in GHK, where the maximum average rainfall was 0.279 inches, double the average rainfall of the wettest Election Day in Sweden. In some US counties in 1972, rainfall exceeded over 4 inches. However, this merely reflects the more moderate Swedish climate, and is not unexpected given normal levels of rain in September. During the period 1961–1990, normal precipitation in September was in Sweden 2.5 inches for the whole month (SMHI, 2013). In the US, average precipitation for November was 2.1 inches during the same period (National Climatic Data Center, 2013), which indicates that the weather conditions *on average* are comparable to the US. So while the average levels of rain are quite similar, the variation is larger in the US than in Sweden. From previous studies it is now unclear if the range of rain matters in relation to voter turnout. Hence, at this stage it is an open question if there is a linear effect of rain, i.e. if the cost effect of rain gets stronger as rainfall increases or if what matters is only whether it rains enough to be inconvenient to get out.

In Fig. 2, the rainfall and turnout levels by municipality in the 1985 election to the Riksdag are displayed, rainfall in the left graph and turnout in the right. Darker colors indicate higher levels of rainfall and turnout. At first glance, no obvious negative correlation can be found between rainfall and turnout, but more sophisticated analysis is obviously called for, which we proceed with in the next section.

## 4. Results

Table 1 presents the results of the analyses on the aggregate-level dataset. In the first model, we use the same estimation method as is employed by GHK. The effect of

[4] Since parliamentary elections in Sweden always take place in September when the temperature is still relatively high, precipitation in the form of snow is extremely rare and is therefore not included in the analysis.

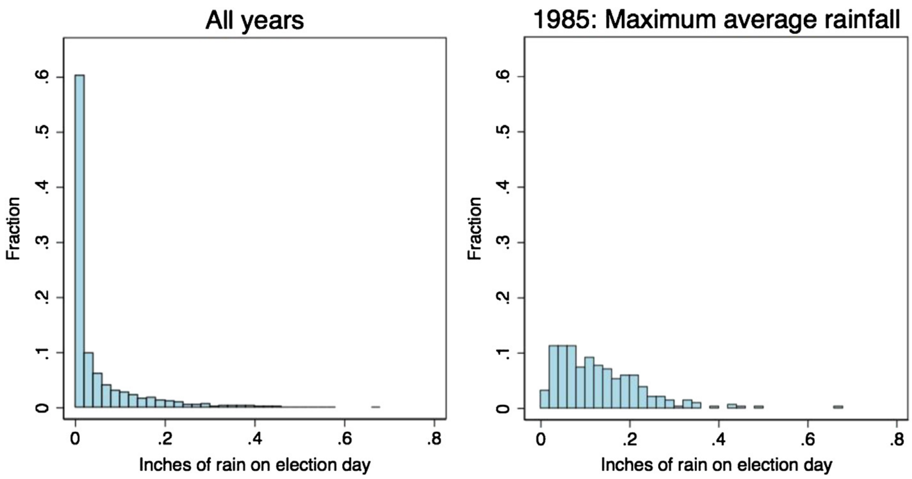


**Fig. 1.** Histogram of rainfall on election day in municipalities all years in the sample (left panel) and only the year with maximum average rainfall (right panel).

one inch of rain on the election day lowers turnout with 0.413 percentage points, which is half the effect reported by GHK, but still statistically significant. However, looking at the unexplained variance at the two levels, it is clear that the model explains all variance at the second (municipal) level. In GHK's model, there remains unexplained variance at the second level, even with all the control variables in the model. One possible reason for this divergence is that Sweden is a smaller and more homogenous country than the US, but also that we study fewer elections, which leads to lower within-municipality variation.

The absence of unexplained variation at the second level means that the results are identical to a simple OLS regression. We therefore also estimate the model with OLS regression, but with dummy variables for each municipality, as GHK do in their methodological appendix. When GHK do so, the effect of rain increases in size to −0.977. As can be seen in model 2 presented in Table 1, the contrary happens in our model: the effect is diminished to −0.257, and is no longer statistically significant. Which of the two estimates is more reliable? In their methodological appendix, GHK argue that the inclusion of fixed effects is inappropriate for econometric reasons when the number of units (municipalities or counties) are greater than the number of time points (elections). However, since the main independent variable in this study is supposed to be close to randomly distributed, this should not be a problem. Without the fixed effects, we run the risk of picking up the effect of unobserved variables that are correlated with rainfall. It is possible that there usually is more rainfall in areas where turnout is high. This could explain why the effect increases in size when fixed effects are included in GHK's models. In Sweden, rainfall is usually heavier in areas with lower turnout (northern Sweden), giving rise to the partially spurious correlation in Model 1. Our conclusion is thus that rain on Election Day is unlikely to affect aggregate turnout negatively.

Next, we turn to results from the Swedish National Election Studies. In addition to test the main effect of rain, previous research using individual-level data has also shown that rain on the Election Day has a larger effect on prospective voters with lower levels of self-reported sense of civic duty (Knack, 1994). The Swedish National Election Studies data does however not include any measure of civic duty in all the surveys. For that reason we use political interest as a proxy for civic duty, in order to test Knack's claim about an interaction effect. Furthermore, we are (as GHK) unable to clear out those that voted absentee before election day in the aggregate analysis, but we are able to do so when we now focus on individual level analyses. We use the same dependent variable as in the first analysis, rain in inches on Election Day, interpolated to each municipality using GIS. The model is a Maximum Likelihood multi-level logit model, with individuals nested in municipalities. In addition to rain and self-reported political interest, we control for income level, education, age and a squared age term. Results are presented in Table 2. First we estimate a model with rain and year dummies with control variables and then include an interaction term between rain and political interest.

In model 1, the control variables perform as expected. The coefficient for Election Day rain is positive but the standard error exceeds the point estimate: rain has no effect. In the second model, we include an interaction term between the two continuous variables Election Day rain and political interest. A higher value on the political interest variable represents a more active interest. In contrast to the interaction effect found in the US by Knack (1994), no interaction effect is found in our data.

So far, the conclusion reached by GHK with US data does not seem to be valid for Sweden. But it is possible that a supposedly very small effect, as the one investigated drowns in the random noise of our datasets. A final test is therefore performed on a third dataset, covering only three elections (2002, 2006 and 2010) but with a total sample including close to 190,000 individuals, obtained from Statistics Sweden. However, as in the previous individual-level analysis, all those who voted early are excluded and we focus only on the subpopulation consisting of those who had not already voted before the

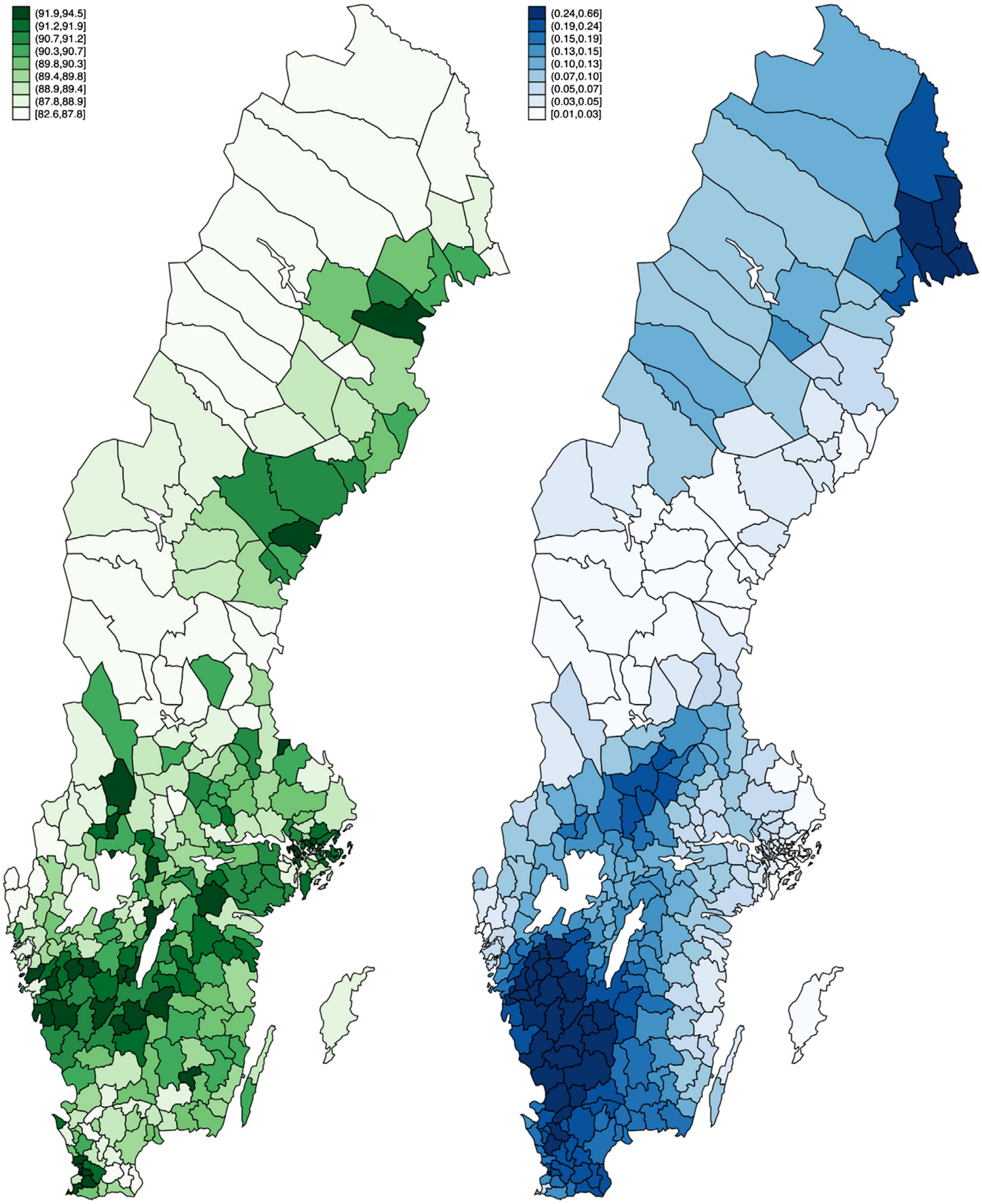


**Fig. 2.** Turnout (green map, left) and rainfall (blue map, right) on election day, September 15th 1985. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Election Day. The number of individuals that the estimation is based on is thereby reduced, but it still consists of close to 140,000 individuals.

As with the other individual-level dataset, we estimate two models. First, we estimate a model with Election Day rain, dummy variables for election years and a set of control variables as independent variables. In our second model we also add some interaction terms. The control variables are all obtained from national registers and they include sex, age, education, income and whether the individual was born in Sweden or not. Education is coded as a dichotomous variable that refers to whether a post-secondary education is completed or not. Income is the income per month in thousands of SEK. We estimate our models using logistic regression that take the complex survey design into account, i.e. the standard errors reflect the unequal inclusion probabilities (the standard errors are robust).

**Table 1**
Aggregate level: Effects of Weather on Municipality-Level Voter Turnout in Sweden 1979–2010.

| Independent variable | Model 1: ML multi-level model | Model 2: OLS with fixed effects (robust standard errors) |
|---|---|---|
| Election day rain (inches) | −0.413* (0.196) | −0.257 (0.186) |
| $\text{Turnout}_{t-1}$ | 0.933* (0.00750) | 0.642* (0.0281) |
| Population size (log) | 0.116* (0.0189) | 1.752* (0.257) |
| % Immigrants (log) | −0.195* (0.0273) | 0.143* (0.059) |
| Area size (log) | −0.0912* (0.0151) | – |
| Intercept | 6.598* (0.727) | 14.642* (2.287) |
| Year fixed effects | Yes | Yes |
| Municipality fixed effects | No | Yes |
| SD of error term at municipal year level | 0.700* (0.018) | |
| SD of intercept at municipal level | 0.000 (0.000) | |
| $N$ | 3128 | 3128 |
| Municipalities | 290 | 290 |
| $R^2_{\text{adj}}$ | | 0.97 |
| Log restricted-likelihood | −3908.5 | |

Comment: Unstandardized b-coefficients, standard errors in parentheses, $^*p < 0.05$.

The findings of the first individual-level analysis are corroborated when using this large-scale data presented in Table 3. In the first model we include rain and our set of control variables. The effect of rainfall on voter turnout is negative, as expected, but it is far from significant. The standard error for the estimate is very large. All the control variables have the expected sign: women, Swedish-born, people with higher education and higher income are all more likely to vote.

In the second model we also include a set of interaction variables. They are interactions between rainfall and the control variables representing income, education and whether the individual is foreign-born or not. In that model, none of these interaction variables have a significant effect on the likelihood of voting. The effect of rainfall on voter turnout is still negative and somewhat larger, but it is still far from significant. The coefficients of all the control variables are almost the same as in the first model and they are still highly significant. Hence, a robust and significant effect of rainfall on voter turnout cannot be found even with this very large dataset.[5]

**Table 2**
Individual level: Effects of rain on probability of turnout in Sweden 1991–2006, Swedish National Election Studies data. Multi-level models.

| Independent variable | Model 1: control variables | Model 2: interaction |
|---|---|---|
| Election day rain (inches) | 0.587 (0.623) | 0.610 (1.138) |
| Political interest (0–3) | 0.576* (0.0598) | 0.576* (0.0635) |
| Income (0–7) | 0.114* (0.0411) | 0.114* (0.0411) |
| Education | 0.438* (0.0665) | 0.438* (0.0665) |
| Age | 0.0588* (0.0152) | 0.0588* (0.0152) |
| $\text{Age}^2$ | −0.000442* (0.000159) | −0.000442* (0.000159) |
| Rain × political interest | | −0.0196 (0.783) |
| Intercept | −1.729* (0.340) | −1.729* (0.340) |
| Year fixed effects | Yes | Yes |
| SD of intercept at municipal level | 0.219* (0.0943) | 0.219* (0.094) |
| $N$ | 5841 | 5841 |
| Municipalities | 283 | 283 |
| Log likelihood | −1881.1886 | −1881.1883 |

Comment: unstandardized b-coefficients, standard errors in parentheses, $^*p < 0.05$.

**Table 3**
Individual level: Effects of rain on probability of turnout in Sweden 2002-2010, Statistics Sweden data. Logistics regressions.

| Independent variable | Model 1: control variables | Model 2: interactions |
|---|---|---|
| Election day rain (inches) | −0.201 (0.207) | −0.361 (0.403) |
| Woman | 0.201* (0.018) | 0.201* (0.018) |
| Income (thousands of SEK/month) | 0.037* (0.001) | 0.036* (0.001) |
| Post-secondary education | 0.890* (0.022) | 0.884* (0.024) |
| Foreign-born | −0.939* (0.025) | −0.945* (0.028) |
| Age | 0.059* (0.003) | 0.059* (0.003) |
| $\text{Age}^2$ | −0.001* (0.000) | −0.001* (0.000) |
| Rain × income | | 0.006 (0.024) |
| Rain × post-secondary education | | 0.251 (0.457) |
| Rain × foreign-born | | 0.272 (0.513) |
| Constant | −0.699* (0.055) | −0.695* (0.056) |
| Year fixed effects | YES | YES |
| $N$ | 138,405 | 138,405 |
| F-value | 791.60 | 594.70 |

Comment: Unstandardized b-coefficients, linearized robust standard errors in parentheses, estimated when taken survey design into account, $^*p < 0.05$.

## 5. Conclusion

Gomez, Hansford and Krause have convincingly shown that rain on the day of presidential elections has a small detrimental effect on turnout in the US. However, this does not seem to be the case in Swedish elections. In three different datasets, covering at most 11 elections or over 140,000 individuals, we cannot find a robust and statistically significant negative effect of Election Day rain on turnout. Hence, the widespread belief, expressed in news media and among academics, that rain has a negative effect on voter turnout gains no support in our data.

What does this add to our understanding of voting in the US and Swedish contexts? Since previous studies have largely focused on the US, there is an obvious need for further tests in other context to test the generalizability of the results. This study brings the important message that the negative effect of rain on voter turnout is far from universal.

We cannot empirically determine the exact causal mechanism at work that explains the different effects of rain in the two different contexts. But a reasonable interpretation

[5] All the analyses have also been rerun using an alternative independent variable consisting of the deviation in rainfall from the municipal average in the sample. None of the conclusions is substantially affected. In a model equivalent to the first model in Table 3 but in which deviation from normal rainfall is used instead of our normal rain variable, a significant negative effect is found. However, the standard error is very large and the effect becomes insignificant if we exclude the control variables or if we add additional control variables, i.e. the effect is not robust. Also, the negative effect of rain in the first model of the municipal-level analysis is rendered insignificant.

is that this is due to the fact that the Swedish electoral system has lower barriers; it is generally easier to vote, and a minor obstacle like rain is hence unlikely to deter many from voting. In addition, it might be the case that Swedes feel a greater compulsion and sense of duty to vote given the relatively high levels of turnout, that more people in Sweden believe that there votes are pivotal or that there is a stronger cultural attachment to the act of voting. Given these strong positive influences on voter turnout, small additional costs of voting, such as rain, do not seem to have any negative effects. Hence, we suggest that the marginal voter in American elections is more easily deterred. Given that the costs of voting in the US are higher, additional costs such as Election Day rain may be the straw that breaks the camel's back and causes people not to vote. But it should also be kept in mind that the range of rainfall is smaller in Sweden than in the US, and hence we should be careful to not draw too strong generalizations from this study. A more general conclusion of our results is that even if effects of rain on voting can only be found is some contexts, one should be careful not to generalize those results to other settings where costs and benefits of voting are substantially different. Future studies would benefit from further analyzing under what conditions rainfall affects voting.

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