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Weather conditions and political party vote share in Dutch national parliament elections, 1971–2010

Rob Eisinga · Manfred Te Grotenhuis · Ben Pelzer

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Abstract Inclement weather on election day is widely seen to benefit certain political parties at the expense of others. Empirical evidence for this weather-vote share hypothesis is sparse however. We examine the effects of rainfall and temperature on share of the votes of eight political parties that participated in 13 national parliament elections, held in the Netherlands from 1971 to 2010. This paper merges the election results for all Dutch municipalities with election-day weather observations drawn from all official weather stations well distributed over the country. We find that the weather parameters affect the election results in a statistically and politically significant way. Whereas the Christian Democratic party benefits from substantial rain (10 mm) on voting day by gaining one extra seat in the 150-seat Dutch national parliament, the left-wing Social Democratic (Labor) and the Socialist parties are found to suffer from cold and wet conditions. Cold (5°C) and rainy (10 mm) election day weather causes the latter parties to lose one or two parliamentary seats.

Keywords Weather conditions · Party vote shares

Introduction

There are two conventional wisdoms about weather and electoral participation (see Knack 1994; Gomez et al. 2007; and references therein). One is that inclement weather on election day reduces voter turnout, whereas pleasant weather encourages people to vote in greater numbers. The common belief is that poor weather drives down

turnout as voters would be less willing to venture out of doors to the polling places if they have to deal with rain, low temperatures and other inclement weather. Hence weather makes going to the polls more or less costly depending on the outside conditions. Some U.S. studies (Merrifield 1993; Shachar and Nalebuff 1999; Gatrell and Bierly 2002; Gomez et al. 2007) as well as our recent Dutch research (Eisinga et al. 2011) support the notion that rainfall diminishes turnout. The weather effects we found are modest in size, however, with a maximum downturn of approximately 1.5% in Dutch parliamentary turnout.

The other long-held belief is that depressed voter turnout attributable to poor weather benefits some political parties at the expense of others. In the two-party U.S. system, where Republicans and Democrats dominate presidential voting, rainy weather is taken to lower the Democratic party's relative vote share rather than Republican voting (Knack 1994; Gomez et al. 2007). The argument goes that more Democrats live in urban areas and therefore rely more strongly on transportation that is susceptible to weather, such as walking and public transit, to get to the polls. A rainy election day may discourage many Democrat voters from waiting for busses and from standing in long lines at busy urban polling places. Also, the popular wisdom is that Republicans are favored by lower turnout due to precipitation since supposedly some key Democratic voting blocks, such as the elderly, are more weather sensitive than the rest of the voting population.

In the same vein, one of the enduring myths of multi-party Dutch politics is that inclement weather on election day hurts the left-wing Social Democratic (Labor) and Socialist parties more than other political parties, such as the Christian Democratic party. Unpleasant weather, so the logic goes, prevents traditional Labor and Socialist supporters such as the poor, unemployed and elderly citizens from casting their ballot. Fine weather, on the

R. Eisinga (✉) · M. Te Grotenhuis · B. Pelzer
Radboud University Nijmegen,
Nijmegen, Netherlands
e-mail: r.eisinga@maw.ru.nl

other hand, sees Labor and Socialist supporters turning out to vote in greater numbers, stopping off at the polling station on their way to or from work.

Little empirical work has been done, however, either to justify or to refute statements about weather's contribution to voting with comprehensive and reliable data. Gomez et al. (2007) examined the effect of weather conditions in 14 U.S. presidential elections and in their study rainfall is shown to benefit the Republican party's vote share. But apart from this exhaustive work the academic literature provides little evidence on the role weather plays in electoral politics.

This study examines the effects of rainfall and temperature on share of the votes of eight political parties and party groupings that participated in 13 national parliament elections, held in the Netherlands from 1971 to 2010. It matches for each election the voting results of over 400 Dutch municipalities with election-day weather observations drawn from the weather station closest to the polls.

Data and method

The local election-day rainfall amount in millimeters and daily mean temperature in degrees Celsius were obtained from all available weather stations of the Royal Netherlands Meteorological Institute. During the time period in question the Netherlands had 17 to 35 meteorological stations and 222 to 235 precipitation stations, with the number of stations increasing over time. The weather station closest to the local municipality was selected using the Haversine equation, giving the shortest distance between station and municipality from their longitudes and latitudes. The temperature readings were obtained from the nearest meteorological station. The mean distance between municipality and meteorological station was 17.7 km (SD 9.8). The daily mean outside temperature ranged from 1.7 to

19.9°C, with a mean of 12°C (SD 4.4). The amount of rainfall was obtained from the closest precipitation station, the mean distance between municipality and precipitation station being 4.4 km (SD 2.3). Local rainfall on election day ranged from 0 to 43.9 mm (mean 2.6, SD 4.0).

The municipality voting figures were obtained from the Dutch Electoral Council. They include, for each municipality, the number of voters eligible to vote, the number of voters who casted (valid, invalid and blank) votes and the number of valid votes for the participating political parties. The municipalities—growing in number over time from 412 to 425 by creating new land from sea—were classified according to the 2010 codes issued by Statistics Netherlands. Municipality turnout is the percentage of eligible voters in a municipality who voted in the election, whereas party vote share is the percentage of the total valid votes obtained by a party in a municipality. Turnout varied from 56.5 to 100%, with a mean of 83.3% (SD 5.8). The party vote shares were obtained for the parties that participated in (almost) all of the elections surveyed. Votes for parties that contested in one or a few elections were collapsed into the category called 'Other parties'. Table 1 offers a description of the Dutch political parties in terms of vote share and the left-right ideological position and church membership of their voters. The parties are sorted from top to bottom according to the voters' left-right political orientation (Eisinga and Franses 1996).

The political parties include three major and four minor Dutch parties in terms of vote shares. The major parties are the CDA: a right-of-the-center Christian Democratic party with a mean share of the vote aggregated over elections of 27.9% (SD 4.5); the PvdA: a left-wing Social Democratic (Labor) party (mean 26.4%, SD 4.4); and the VVD: a right-wing Liberal party (mean 17.7%, SD 3.8). The minor parties include GL: a left-wing (green) environmentalist party (mean 5.8%, SD 2.3); the SP: a left-wing Socialist party (mean 4.3%, SD 2.0); D66: a center-Liberal party

Table 1 Dutch political parties

| Abbreviation | Dutch name | English equivalent | Vote share | Left-right | Church |
|---------------|---|--|------------|------------|--------|
| GL | GroenLinks | GreenLeft | 5.8 | 2.5 | 0.39 |
| SP | Socialistische Partij | Socialist Party | 4.3 | 2.8 | 0.42 |
| PvdA | Partij van de Arbeid | Social Democratic (Labor) Party | 26.4 | 3.0 | 0.49 |
| D66 | Democraten 66 | Democrats 66 | 6.7 | 3.6 | 0.49 |
| CDA | Christen Democratisch Appel | Christian Democratic Appeal | 27.9 | 4.8 | 0.93 |
| VVD | Partij voor Vrijheid en Democratie | People's Party for Freedom and Democracy | 17.7 | 4.9 | 0.56 |
| CU/SGP | Christen Unie / Staatskundig Gereformeerde Partij | Christian Union / Reformed Political Party | 4.3 | 5.7 | 0.98 |
| Other parties | | | 7.2 | 4.4 | 0.69 |

Vote share is the party's observed percentage of the votes aggregated over the 13 national parliament elections, 1971–2010. Left-right indicates the mean ideological position of the party supporters on a 7-point scale running from left (1) to right (7). The column labeled 'church' offers the proportion of the party supporters who consider themselves (Catholic or Protestant) church members. The figures in the two right-most columns were taken from sample survey data ($N=871,844$) collected in the 1976–2000 period (Source: Eisinga 2005)

(mean 6.7%, SD 2.5); and CU and SGP: two right-wing orthodox religious parties collapsed into a single category (mean 4.3%, SD 2.0). The mean share of the vote for ‘Other parties’ is 7.2% (SD 2.6). The 5,507 observation counts (i.e., number of municipalities times number of elections) for each party’s vote share represent 113 million valid votes and 28 million abstentions (including half million invalid and blank votes).

The model we used examines the effect of rainfall and temperature on share of the votes for each contesting party separately. In addition to their main effects we also investigated the potential joint effect of the two weather variables, as the interplay of a cold and rainy day may be the major weather issue that keeps voters from going to the polls. In order to mitigate confounding influences, the weather effects were controlled for the weather-related variable electoral turnout and other variables.

Party vote shares at the municipality level are strongly related across elections as a result of party loyalty. To account for this temporal continuity the model incorporates the share of the vote for the party in question in the two preceding elections by including their moving average. The vote shares for the elections prior to 1971 were additionally coded to obtain complete observations for the first two elections. Because contemporary issues and changing domestic and international affairs all contribute to the uniqueness of a particular national election, election dummy variables were entered in the model that allow the election intercepts to vary.

Some party strongholds are to a lesser or greater extent geographically concentrated in particular Dutch regions. The southern part of the Netherlands is a traditional Christian Democratic stronghold, for example, and there is a strip of land called the Dutch Bible Belt which is inhabited mainly by conservative Protestants overwhelmingly voting for CU or SGP. To account for this regional concentration, the municipality's longitude and latitude (in degrees, decimal degrees) were included in the model. Finally, the municipality voting-age population density was used as demographic control. The variable included in the analysis is the natural logarithm of the number of eligible voters per municipality square kilometer.

The data were analyzed party-by-party using two different three-level hierarchical models—linear and logistic—with voters for a particular party at level one, nested within municipality-by-election at level two and municipality at level three. As the parameter estimates of the linear and logistic models obtained identical effect signs and near equivalent *p*-values, we opted for the presentation of the results of the linear models as they are easier to communicate.

Results

The effects of the weather parameters on each of the party’s share of the vote are presented in Table 2. We restrict our discussion to the most important results.

Table 2 Maximum-likelihood hierarchical linear models of municipality-level political party’s share of the votes in Dutch national parliament elections, 1971–2010

| Independent variables (iv) | GL | SP | PvdA | D66 | CDA | VVD | CU/SGP | Other parties |
|-----------------------------------|---------------------|---------------------|--------------------|---------------------|---------------------|---------------------|--------------------|---------------|
| Fixed effects | | | | | | | | |
| Intercept (iv mean centered) | 5.36 (0.14) | 2.83 (0.10) | 22.87 (0.23) | 7.78 (0.13) | 29.83 (0.27) | 14.97 (0.19) | 6.45 (0.10) | 9.37 (0.17) |
| Rainfall (mm) | 0.02 (0.01) | -0.07 (0.01) | -0.07 (0.01) | 0.02 (0.01) | 0.13 (0.02) | <i>-0.01 (0.01)</i> | 0.02 (0.01) | -0.05 (0.01) |
| Temperature (°C) | <i>-0.02 (0.02)</i> | -0.04 (0.01) | <i>0.00 (0.03)</i> | 0.04 (0.01) | <i>0.04 (0.03)</i> | <i>-0.00 (0.02)</i> | 0.05 (0.01) | -0.06 (0.02) |
| Rainfall × temperature | <i>-0.00 (0.00)</i> | 0.02 (0.00) | 0.02 (0.00) | <i>-0.00 (0.00)</i> | <i>-0.01 (0.00)</i> | 0.01 (0.00) | <i>0.00 (0.00)</i> | -0.02 (0.00) |
| Moving average vote share | | | | | | | | |
| previous two elections | 0.29 (0.01) | 1.11 (0.01) | 0.82 (0.01) | 0.40 (0.02) | 0.81 (0.00) | 0.75 (0.01) | 1.01 (0.00) | 0.48 (0.01) |
| Electoral turnout | 0.02 (0.01) | -0.06 (0.00) | -0.03 (0.01) | <i>-0.01 (0.01)</i> | 0.09 (0.01) | -0.11 (0.01) | <i>0.01 (0.00)</i> | -0.08 (0.01) |
| Municipality latitude | 0.61 (0.11) | <i>-0.06 (0.03)</i> | <i>0.11 (0.10)</i> | 0.27 (0.08) | -0.35 (0.11) | 0.66 (0.13) | 0.11 (0.03) | -0.48 (0.06) |
| Municipality longitude | 0.23 (0.09) | 0.14 (0.03) | 0.72 (0.07) | -0.34 (0.06) | 0.39 (0.08) | -1.19 (0.11) | 0.11 (0.02) | -0.37 (0.04) |
| Log voting-age population density | 0.68 (0.06) | -0.06 (0.02) | 0.25 (0.05) | 0.41 (0.04) | -0.56 (0.06) | <i>-0.12 (0.07)</i> | <i>0.01 (0.02)</i> | 0.11 (0.03) |
| Random effects | | | | | | | | |
| Fitted model | | | | | | | | |
| Municipality × election | 1.65 (0.03) | 1.37 (0.03) | 5.94 (0.16) | 1.34 (0.03) | 7.82 (0.17) | 2.72 (0.06) | 1.20 (0.02) | 3.56 (0.07) |
| Municipality | 1.43 (0.12) | 0.00 (0.00) | 0.53 (0.21) | 0.61 (0.07) | 0.51 (0.12) | 2.00 (0.32) | 0.00 (0.00) | 0.07 (0.03) |
| Null model | | | | | | | | |
| Municipality × election | 4.18 (0.08) | 26.70 (0.55) | 35.81 (0.71) | 12.52 (0.25) | 76.34 (1.52) | 20.19 (0.40) | 1.55 (0.03) | 38.93 (0.74) |
| Municipality | 3.41 (0.26) | 0.00 (0.00) | 55.16 (3.98) | 1.98 (0.20) | 100.87 (7.33) | 31.71 (2.28) | 58.68 (4.03) | 0.00 (0.00) |
| Proportional reduction in error | 0.59 | 0.95 | 0.93 | 0.87 | 0.95 | 0.91 | 0.98 | 0.91 |

Standard error in parenthesis. The parameter estimates are significant at the 0.05 level, except those reported in italic. Fixed effects of the election dummy variables are not reported. The estimates can be obtained from the authors. The parameters of the SP vote share were estimated for the 11 elections held in the 1977–2010 period. The proportional reduction in prediction error is obtained as the ratio of explained variation to total variation and may be interpreted as indicating the proportion of variation explained. Descriptions of the abbreviations can be found in Table 1

Rainfall was seen to have a significant negative effect on the vote shares of the Socialist party SP, the Social Democratic party PvdA, and the Other parties, and a positive effect on the vote shares of the Christian Democratic party CDA, the center-liberal party D66, the left-wing environmentalist party GL, and the orthodox religious parties CU/SGP. The outside temperature was found to have a significant positive effect on the shares of the vote for D66 and CU/SGP, and a negative effect on the SP's vote share and those of the Other parties. Equally or even more important, temperature is observed to modify the effect of rainfall, most notably in the case of the Social Democratic party PvdA and the Socialist party SP. Basically, the detrimental effect of rain on the Social Democratic and the Socialist party vote shares diminishes as the outside temperature increases.

With respect to the non-weather variables we note that a large turnout benefits the left-wing environmentalist party GL and the Christian Democratic party CDA and not, as frequently claimed, the Social Democratic party PvdA. The estimates for municipality latitude confirm that much of the Christian Democratic electorate is concentrated in the southern part of the country.

To examine the political significance of the weather parameters, Table 3 displays the predicted deviations in terms of number of seats in parliament from the party's estimated mean seat count for three settings of rainfall (0, 5, 10 mm) as well as temperature (5, 10, 15°C).

The Dutch national parliament has 150 seats that, once the election results are known, are allocated to the contesting parties. The number of votes cast is divided by the 150 seats available, to render a threshold for each seat. Each party's number of votes is divided by this threshold to give an initial number of seats. Any party that received fewer votes than the threshold fails to gain representation in parliament. After the initial seats are allocated, the remainder seats are allotted. If we disregard both the method of allocating remainder seats and electoral alliances of parties to gain remainder seats, we may equate a single seat to represent $(100/150 \approx) 0.667\%$ of the votes.

With this in mind, Table 3 reveals that the weather parameters have a politically significant effect on the seat gains and losses for some political parties. Most notable are the consequences for the Social Democratic party PvdA and the Socialist party SP on the one hand and the Christian Democratic party CDA on the other. The two left-wing parties seem to profit from cold (5°C) and dry (0 mm rainfall) conditions. However, if the weather is both cold and wet (10 mm), the Social Democratic party PvdA is seen to lose 1 (10°C) to 2 seats (5°C) in parliament. About the same results go for the Socialist party SP. The Christian

Table 3 Predicted mean deviations in number of parliamentary seats from party's estimated mean seat count by rainfall (mm) and temperature (°C), 1971–2010

| Temperature (°C) | Rainfall (mm) | | |
|-------------------------------------|---------------|--------------|--------------|
| | 0 | 5 | 10 |
| GL (mean 7.94, SE 0.11) | | | |
| 5 | 0.06 (0.20) | 0.40 (0.23) | 0.74 (0.33) |
| 10 | -0.04 (0.13) | 0.16 (0.13) | 0.36 (0.18) |
| 15 | -0.14 (0.13) | -0.08 (0.13) | -0.01 (0.15) |
| SP (mean 6.72, SE 0.04) | | | |
| 5 | 1.17 (0.18) | -0.15 (0.21) | -1.48 (0.30) |
| 10 | 0.56 (0.08) | -0.19 (0.09) | -0.94 (0.14) |
| 15 | -0.06 (0.06) | -0.23 (0.06) | -0.41 (0.09) |
| PvdA (mean 39.15, SE 0.09) | | | |
| 5 | 0.88 (0.33) | -0.74 (0.39) | -2.36 (0.59) |
| 10 | 0.48 (0.14) | -0.37 (0.16) | -1.23 (0.28) |
| 15 | 0.08 (0.16) | -0.13 (0.16) | -0.11 (0.22) |
| D66 (mean 10.04, SE 0.08) | | | |
| 5 | -0.57 (0.17) | -0.37 (0.20) | -0.16 (0.29) |
| 10 | -0.24 (0.09) | -0.06 (0.10) | 0.12 (0.15) |
| 15 | 0.09 (0.10) | 0.25 (0.10) | 0.41 (0.12) |
| CDA (mean 41.97, SE 0.10) | | | |
| 5 | -1.20 (0.37) | 0.17 (0.44) | 1.53 (0.67) |
| 10 | -0.74 (0.16) | 0.32 (0.18) | 1.38 (0.31) |
| 15 | -0.28 (0.18) | 0.47 (0.18) | 1.22 (0.24) |
| VVD (mean 27.18, SE 0.13) | | | |
| 5 | 0.26 (0.25) | -0.21 (0.29) | -0.69 (0.42) |
| 10 | 0.12 (0.15) | -0.09 (0.16) | -0.30 (0.22) |
| 15 | -0.03 (0.16) | 0.03 (0.16) | 0.08 (0.19) |
| CU/SGP (mean 6.48, SE 0.03) | | | |
| 5 | -0.58 (0.14) | -0.45 (0.17) | -0.32 (0.26) |
| 10 | -0.23 (0.06) | 0.09 (0.07) | 0.05 (0.12) |
| 15 | 0.11 (0.07) | 0.26 (0.07) | 0.42 (0.09) |
| Other parties (mean 11.00, SE 0.06) | | | |
| 5 | 0.21 (0.25) | 1.12 (0.29) | 2.03 (0.45) |
| 10 | 0.23 (0.10) | 0.22 (0.12) | 0.20 (0.21) |
| 15 | 0.26 (0.12) | -0.68 (0.12) | -1.62 (0.16) |

Standard error in parenthesis. Descriptions of the abbreviations can be found in Table 1

Democratic party, on the contrary, is predicted to benefit from an extremely rainy (10 mm) election day, irrespective of temperature, and to gain one extra seat in parliament under such conditions. Cold (5°C) and dry (0 mm) election day weather cause this party to lose a seat in parliament however. The electoral gains and losses experienced by these three parties either impose costs on or create benefits for the Other parties. The remaining political parties are shown neither to win nor to lose in an electorally significant manner as a result of inclement weather.

Discussion

This paper validates the long-held belief in Dutch politics that inclement weather on election day—measured by local rainfall and low temperatures—diminishes the share of the vote received by the left-wing Social Democratic (Labor) party and the Socialist party. However, the impact is not as strong as many people, politicians and journalist alike, believe it to be. Cold and rainy election day weather causes these parties to lose one or two seats in the 150-seat Dutch national parliament. Their major opponent, the Christian Democratic party, is shown to profit electorally from an extremely rainy election day as it offers the party one additional seat in parliament.

The possible causes of the left-wing parties' losses have been discussed above. One explanation for the weather-related seat gain of the Christian Democratic party is that the party is exclusively supported by religious people. It may be that the religious part of the electorate has a somewhat higher level of civic duty which prevents them from letting the rain stop their voice from being heard. An additional explanation may be that the Christian Democratic party is traditionally sought to represent the interests of farmers and fishermen, who are used to work in all kinds of weather, and their families.

However this may be, our results indicate that the left-wing Social Democratic and Socialist parties should cross their fingers for dry and cold temperatures on Dutch

election day, whereas Christian Democrat supporters should pray for large amounts of rain.

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