
Cumulative voting and preference distribution: a study of electoral reform in Bremen and Hamburg

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Supplementary Material

A. Additional regression models

Table A1: Logistic regression models (standard errors in parenthesis). Table replicates Model 1 from paper for each election separately.

	Bremen '11	Bremen '15	Hamburg '11	Hamburg '15
Relative Approval	-0.12 (0.04)**	-0.26 (0.04)***	-0.15 (0.05)**	-0.19 (0.05)***
Coalition preference	0.35 (0.18)	0.06 (0.20)	-0.02 (0.23)	0.41 (0.30)
Political knowledge	-0.12 (0.14)	0.05 (0.14)	-0.65 (0.18)***	-0.23 (0.19)
Education	0.03 (0.06)	0.01 (0.06)	-0.09 (0.08)	-0.00 (0.08)
Interest in election	-0.12 (0.09)	-0.08 (0.09)	0.02 (0.11)	-0.06 (0.13)
Electoral system eval.	0.52 (0.12)***	0.40 (0.13)**	0.38 (0.17)*	0.06 (0.19)
Party affiliation	-0.48 (0.13)***	-0.34 (0.14)*	-0.65 (0.17)***	-0.63 (0.18)***
Female	0.20 (0.12)	0.34 (0.12)**	0.13 (0.16)	0.32 (0.17)
Age	-0.02 (0.12)	-0.36 (0.14)*	0.02 (0.16)	-0.12 (0.17)
Age squared	-0.00 (0.01)	0.02 (0.01)	-0.01 (0.01)	0.00 (0.01)
AIC	1644.06	1553.75	980.55	842.05
BIC	1700.30	1609.77	1032.58	892.35
Log Likelihood	-811.03	-765.88	-479.27	-410.03
Deviance	1622.06	1531.75	958.55	820.05
Num. obs.	1228	1203	837	715

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table A2: Logistic regression models (standard errors in parenthesis). Model 1 only uses positive approval scores. Model 2 uses the standardised version of Relative Approval which is used for the lower part of Figure A1. Model 3 changes political knowledge from knowing both candidates to the (in the four elections better known) SPD candidate.

	Pos. approval only	Rel. appr. stand.	Diff. pol. knowledge
Rel. Approval (pos. values)	-0.21 (0.03)***		
Coalition preference	0.08 (0.11)	0.11 (0.11)	0.17 (0.11)
Political knowledge	-0.19 (0.08)*	-0.15 (0.08)	
Education	-0.02 (0.03)	0.02 (0.03)	0.00 (0.03)
Interest in election	-0.09 (0.05)	-0.07 (0.05)	-0.07 (0.05)
Electoral system eval.	0.37 (0.07)***	0.36 (0.07)***	0.38 (0.07)***
Party affiliation	-0.55 (0.08)***	-0.52 (0.07)***	-0.49 (0.07)***
Female	0.22 (0.07)**	0.23 (0.07)***	0.26 (0.07)***
Age	-0.14 (0.07)*	-0.12 (0.07)	-0.14 (0.07)*
Age squared	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)
Bremen 2015	-0.05 (0.09)	-0.15 (0.09)	-0.17 (0.09)
Hamburg 2011	-0.62 (0.11)***	-0.74 (0.11)***	-0.80 (0.10)***
Hamburg 2015	-0.61 (0.11)***	-0.77 (0.11)***	-0.70 (0.11)***
Relative approval (standardised)		-1.65 (0.21)***	
Relative approval			-0.18 (0.02)***
Pol. knowledge (SPD candidate)			-0.14 (0.09)
AIC	4701.05	5001.44	5001.69
BIC	4788.03	5089.48	5089.74
Log Likelihood	-2336.52	-2486.72	-2486.84
Deviance	4673.05	4973.44	4973.69
Num. obs.	3690	3976	3983

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table A3: Logistic regression models (standard errors in parenthesis). The first and third model has general split intention as the dependent variable. The second and fourth model use the concrete split intention.

	Diff. 1-2	Diff 1-2 (concrete)	Diff. 1-3	Diff. 1-3 (concrete)
Diff. 1-2	-0.29 (0.03)***	-0.31 (0.03)***		
Coalition preference	0.04 (0.11)	0.82 (0.16)***	0.07 (0.11)	0.86 (0.16)***
Political knowledge	-0.19 (0.08)*	-0.17 (0.09)*	-0.16 (0.08)*	-0.14 (0.09)
Education	-0.01 (0.03)	0.01 (0.04)	0.00 (0.03)	0.03 (0.04)
Interest in election	-0.10 (0.05)	-0.07 (0.06)	-0.08 (0.05)	-0.06 (0.06)
Electoral system eval.	0.36 (0.07)***	0.33 (0.08)***	0.37 (0.07)***	0.32 (0.08)***
Party affiliation	-0.55 (0.07)***	-0.38 (0.09)***	-0.52 (0.07)***	-0.36 (0.09)***
Female	0.24 (0.07)***	0.22 (0.08)**	0.26 (0.07)***	0.24 (0.08)**
Age	-0.14 (0.07)*	-0.22 (0.08)**	-0.14 (0.07)*	-0.21 (0.08)**
Age squared	0.00 (0.01)	0.01 (0.01)	0.00 (0.01)	0.01 (0.01)
Bremen 2015	-0.03 (0.09)	-0.19 (0.10)	-0.07 (0.09)	-0.24 (0.10)*
Hamburg 2011	-0.52 (0.11)***	-0.57 (0.12)***	-0.59 (0.11)***	-0.66 (0.12)***
Hamburg 2015	-0.59 (0.10)***	-0.67 (0.12)***	-0.67 (0.10)***	-0.76 (0.12)***
Diff 1-3			-0.15 (0.02)***	-0.16 (0.02)***
AIC	4959.34	3939.22	4971.40	3961.65
BIC	5047.40	4025.11	5059.40	4047.49
Log Likelihood	-2465.67	-1955.61	-2471.70	-1966.83
Deviance	4931.34	3911.22	4943.40	3933.65
Num. obs.	3983	3412	3965	3398

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

B. Additional plots

The basic conceptualisation of A_r ranges from 0 to 10. The highest A_r value a voter can have is her highest approval of a party when she ranks all other parties at zero. Some voters interpret the approval scale differently. Therefore, we also rescale the index by dividing $\frac{A_r}{A_{max}}$ which results in a scale ranging from 0 to 1. Figure A1 compares the marginal effects of *Relative approval* on split voting for the basic (Model 1 in the paper) and rescaled version (Model 2, Table A2). Figures A2 and A3 show the distribution of *Relative Approval* for the basic (0–10 scale) and standardised (0–1 scale) version. Figures A4 and A5 plot the distribution of the difference between the most liked and second/third most liked party faceted for each election. Figure A6 replicates the predicted probabilities in Figure 4, but uses $\log(1 + \text{difference})$ instead of the *absolute difference* as the independent variable.

Figure A1: Comparing the marginal effect of different relative approval scores on the predicted probability of ticket-splitting.

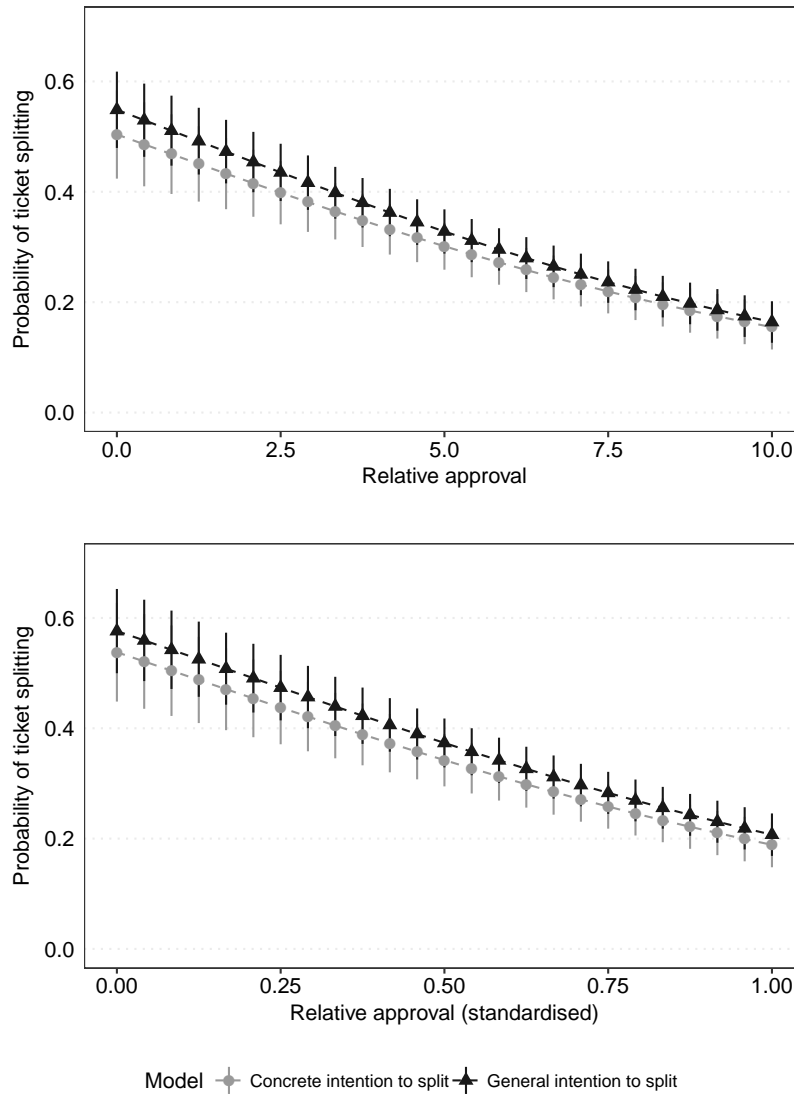


Figure A2: Distribution of the basic conceptualisation of *Relative Approval*.

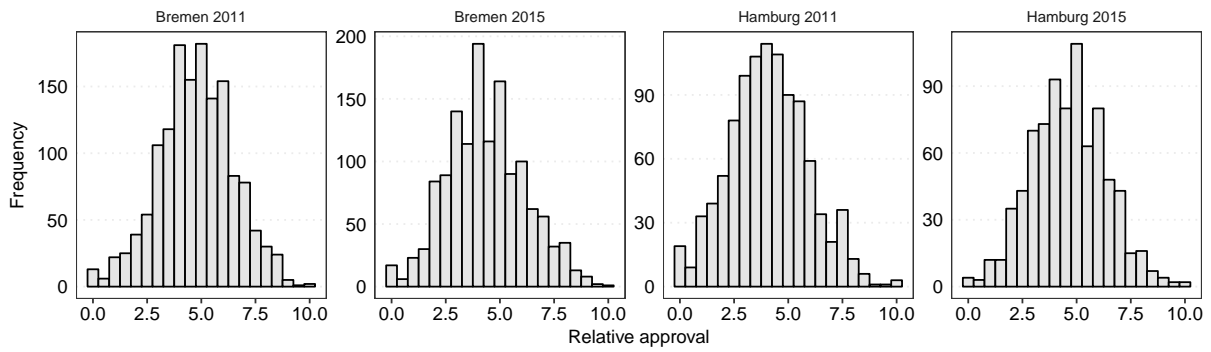


Figure A3: Distribution of the standardised conceptualisation of *Relative Approval*.

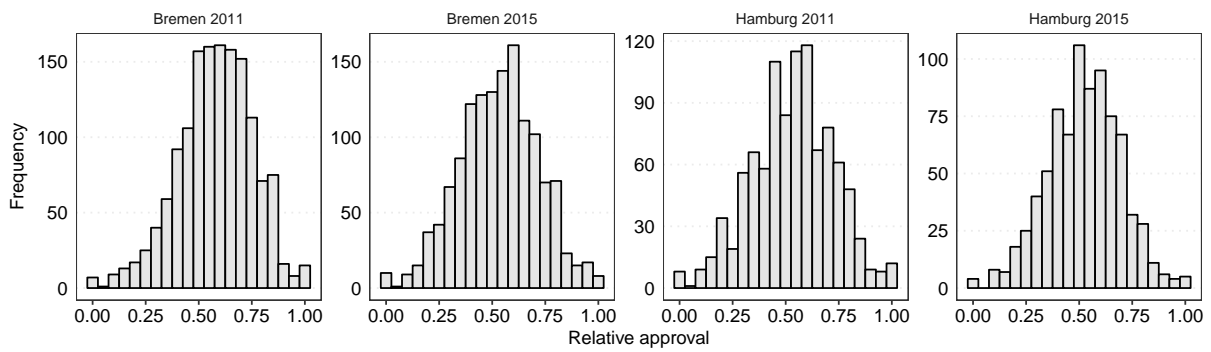


Figure A4: Distribution of the difference between most liked and second most liked party.

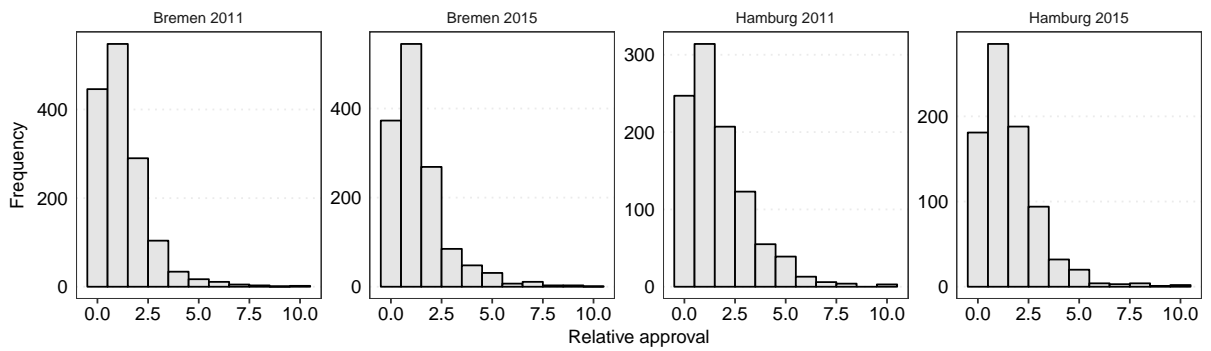


Figure A5: Distribution of the difference between most liked and third most liked party.

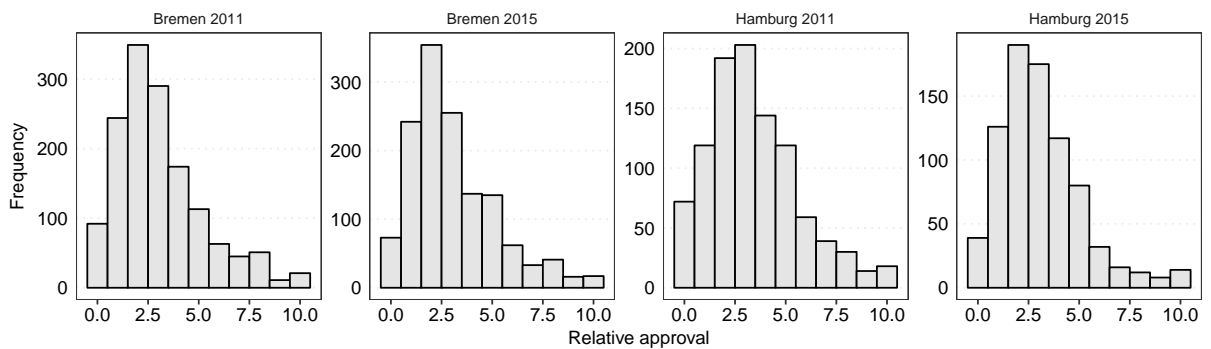
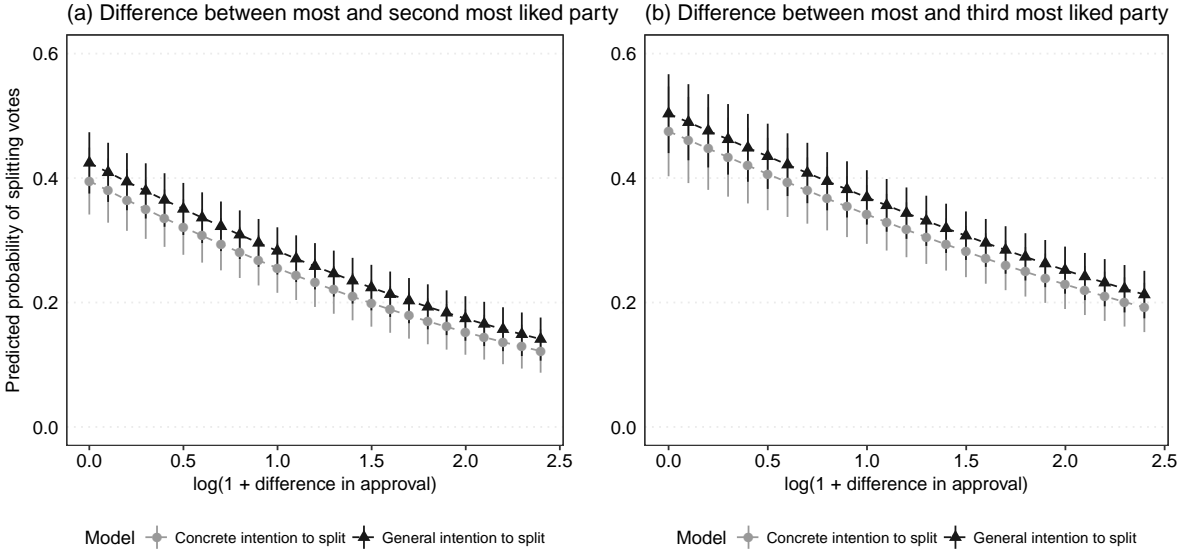


Figure A6: Predicted probability of splitting votes depending on the difference in approval for most and second/third most liked party (logged independent variable).



C. List of all split options across the four elections

Table A4: Overview of all splitting options in descending order (all elections, basis for Figure 1 in the paper)

Split option	Count	Percentage across split voters
SPD, Grüne	469	40.33
CDU, SPD	109	9.37
CDU, FDP	99	8.51
SPD, Linke	69	5.93
Grüne, Linke	61	5.25
SPD, FDP	42	3.61
SPD, Grüne, Linke	36	3.10
CDU, Grüne	26	2.24
CDU, SPD, Grüne	21	1.81
Grüne, FDP	16	1.38
CDU, SPD, FDP	15	1.29
Grüne, Piraten	13	1.12
SPD, Grüne, FDP	10	0.86
Linke, Piraten	9	0.77
SPD, NPD	9	0.77
SPD, Piraten	9	0.77
Grüne, Linke, Piraten	7	0.60
Grüne, Other	7	0.60
Linke, FDP	7	0.60
Linke, Other	7	0.60
SPD, Other	7	0.60
CDU, NPD	6	0.52
CDU, Linke	5	0.43
CDU, Other	5	0.43
CDU, SPD, Grüne, FDP	5	0.43
FDP, Other	5	0.43
SPD, Grüne, Piraten	5	0.43
CDU, FDP, FDP	4	0.34
CDU, Grüne, FDP	4	0.34
CDU, Piraten	4	0.34
FDP, NPD	4	0.34
FDP, Piraten	4	0.34
Linke, NPD	4	0.34
Piraten, Other	4	0.34
SPD, Linke, FDP	4	0.34
SPD, Linke, NPD	4	0.34
CDU, FDP, NPD	3	0.26
CDU, SPD, Grüne, Linke	3	0.26
CDU, SPD, Linke	3	0.26
CDU, SPD, Other	3	0.26
Grüne, Piraten, Other	3	0.26
CDU, FDP, Other	2	0.17
CDU, Grüne, FDP, Piraten	2	0.17
Grüne, Linke, Other	2	0.17
SPD, Grüne, NPD	2	0.17
SPD, Grüne, Other	2	0.17
CDU, FDP, FDP, NPD	1	0.09
CDU, FDP, Piraten	1	0.09
CDU, Grüne, Linke	1	0.09
CDU, Grüne, Linke, FDP	1	0.09
CDU, Grüne, Other	1	0.09
CDU, Grüne, Piraten	1	0.09
CDU, Linke, NPD	1	0.09
CDU, Piraten, Other	1	0.09
CDU, SPD, Grüne, Other	1	0.09
CDU, SPD, Piraten	1	0.09
FDP, FDP	1	0.09
FDP, NPD, Piraten	1	0.09
Grüne, FDP, FDP	1	0.09
Grüne, NPD	1	0.09
Linke, Piraten, Other	1	0.09
NPD, Piraten, Other	1	0.09
SPD, FDP, NPD	1	0.09
SPD, FDP, Other	1	0.09
SPD, Grüne, FDP, Other	1	0.09
SPD, Grüne, Linke, NPD	1	0.09
SPD, Linke, FDP, FDP	1	0.09
SPD, Linke, Other	1	0.09
SPD, Piraten, Piraten, Other	1	0.09

Table A5: Overview of all splitting options in descending order (Bremen 2011)

Split option	Count	Percentage across split voters
SPD, Grüne	208	51.61
CDU, SPD	35	8.68
CDU, FDP	24	5.96
SPD, Linke	13	3.23
Grüne, Linke	12	2.98
SPD, FDP	11	2.73
SPD, Grüne, Linke	10	2.48
CDU, Grüne	9	2.23
CDU, SPD, Grüne	8	1.99
Grüne, Piraten	7	1.74
SPD, Grüne, FDP	7	1.74
CDU, SPD, FDP	6	1.49
Grüne, FDP	5	1.24
CDU, SPD, Grüne, FDP	4	0.99
SPD, Other	4	0.99
CDU, FDP, FDP	3	0.74
FDP, Piraten	3	0.74
SPD, Piraten	3	0.74
CDU, Other	2	0.50
CDU, Piraten	2	0.50
FDP, Other	2	0.50
Grüne, Other	2	0.50
Linke, Other	2	0.50
Linke, Piraten	2	0.50
SPD, Grüne, Piraten	2	0.50
CDU, FDP, Other	1	0.25
CDU, Grüne, FDP	1	0.25
CDU, Grüne, FDP, Piraten	1	0.25
CDU, Grüne, Piraten	1	0.25
CDU, SPD, Other	1	0.25
FDP, FDP	1	0.25
FDP, NPD, Piraten	1	0.25
Grüne, FDP, FDP	1	0.25
Grüne, Linke, Other	1	0.25
Grüne, NPD	1	0.25
Grüne, Piraten, Other	1	0.25
Linke, NPD	1	0.25
Piraten, Other	1	0.25
SPD, FDP, Other	1	0.25
SPD, Grüne, Other	1	0.25
SPD, Linke, NPD	1	0.25
SPD, Linke, Other	1	0.25

Table A6: Overview of all splitting options in descending order (Bremen 2015)

Split option	Count	Percentage across split voters
SPD, Grüne	105	33.02
CDU, FDP	34	10.69
Grüne, Linke	25	7.86
CDU, SPD	24	7.55
SPD, Linke	23	7.23
SPD, FDP	10	3.14
SPD, Grüne, Linke	9	2.83
CDU, Grüne	8	2.52
CDU, SPD, Grüne	8	2.52
Grüne, FDP	7	2.20
Linke, FDP	6	1.89
Grüne, Other	5	1.57
SPD, NPD	4	1.26
CDU, NPD	3	0.94
CDU, Other	3	0.94
Grüne, Linke, Piraten	3	0.94
Linke, Other	3	0.94
CDU, FDP, NPD	2	0.63
CDU, Grüne, FDP	2	0.63
CDU, SPD, FDP	2	0.63
CDU, SPD, Linke	2	0.63
FDP, NPD	2	0.63
FDP, Other	2	0.63
Grüne, Piraten	2	0.63
Linke, NPD	2	0.63
Piraten, Other	2	0.63
SPD, Grüne, FDP	2	0.63
SPD, Linke, FDP	2	0.63
CDU, FDP, FDP	1	0.31
CDU, FDP, Other	1	0.31
CDU, Grüne, FDP, Piraten	1	0.31
CDU, Grüne, Other	1	0.31
CDU, Linke	1	0.31
CDU, SPD, Grüne, Linke	1	0.31
CDU, SPD, Grüne, Other	1	0.31
Grüne, Linke, Other	1	0.31
Grüne, Piraten, Other	1	0.31
Linke, Piraten	1	0.31
Linke, Piraten, Other	1	0.31
SPD, Grüne, FDP, Other	1	0.31
SPD, Grüne, NPD	1	0.31
SPD, Linke, FDP, FDP	1	0.31
SPD, Other	1	0.31
SPD, Piraten	1	0.31

Table A7: Overview of all splitting options in descending order (Hamburg 2011)

Split option	Count	Percentage across split voters
SPD, Grüne	73	40.33
CDU, FDP	25	13.81
SPD, Linke	18	9.94
CDU, SPD	16	8.84
SPD, Grüne, Linke	9	4.97
SPD, FDP	7	3.87
CDU, Grüne	5	2.76
SPD, Piraten	3	1.66
CDU, SPD, FDP	2	1.10
CDU, SPD, Other	2	1.10
Grüne, Linke	2	1.10
Linke, Other	2	1.10
Linke, Piraten	2	1.10
SPD, Other	2	1.10
CDU, Grüne, FDP	1	0.55
CDU, Grüne, Linke	1	0.55
CDU, Piraten, Other	1	0.55
CDU, SPD, Grüne, FDP	1	0.55
CDU, SPD, Linke	1	0.55
FDP, Other	1	0.55
Grüne, FDP	1	0.55
Grüne, Linke, Piraten	1	0.55
Grüne, Piraten	1	0.55
Grüne, Piraten, Other	1	0.55
Piraten, Other	1	0.55
SPD, Grüne, Other	1	0.55
SPD, Linke, FDP	1	0.55

Table A8: Overview of all splitting options in descending order (Hamburg 2015)

Split option	Count	Percentage across split voters
SPD, Grüne	83	31.80
CDU, SPD	34	13.03
Grüne, Linke	22	8.43
CDU, FDP	16	6.13
SPD, Linke	15	5.75
SPD, FDP	14	5.36
SPD, Grüne, Linke	8	3.07
CDU, SPD, FDP	5	1.92
CDU, SPD, Grüne	5	1.92
SPD, NPD	5	1.92
CDU, Grüne	4	1.53
CDU, Linke	4	1.53
Linke, Piraten	4	1.53
CDU, NPD	3	1.15
Grüne, FDP	3	1.15
Grüne, Linke, Piraten	3	1.15
Grüne, Piraten	3	1.15
SPD, Grüne, Piraten	3	1.15
SPD, Linke, NPD	3	1.15
CDU, Piraten	2	0.77
CDU, SPD, Grüne, Linke	2	0.77
FDP, NPD	2	0.77
SPD, Piraten	2	0.77
CDU, FDP, FDP, NPD	1	0.38
CDU, FDP, NPD	1	0.38
CDU, FDP, Piraten	1	0.38
CDU, Grüne, Linke, FDP	1	0.38
CDU, Linke, NPD	1	0.38
CDU, SPD, Piraten	1	0.38
FDP, Piraten	1	0.38
Linke, FDP	1	0.38
Linke, NPD	1	0.38
NPD, Piraten, Other	1	0.38
SPD, FDP, NPD	1	0.38
SPD, Grüne, FDP	1	0.38
SPD, Grüne, Linke, NPD	1	0.38
SPD, Grüne, NPD	1	0.38
SPD, Linke, FDP	1	0.38
SPD, Piraten, Piraten, Other	1	0.38

D. Question wording and variable construction

Dependent variable

- **Split vote:** A dummy variable that takes the value 1 if a respondent reports to split her vote between two or more parties. [Bremen 2011: v3c; Bremen 2015: v3c; Hamburg 2011: v3c; Hamburg 2015: v3c]

Independent variables

- **Age:** A 10-point scale (1=16–17; 2=18–20; 3=21–24; 4=25–29; 5=30–34; 6=35–39; 7=40–44; 8=45–49; 9=50–59; 10=60–69; 11=>70 years). Age is treated as an interval-level [vb; vb; vb; vb]
- **Coalition preference:** A dummy variable that takes the value 1 if a respondent named a coalition she would favour if no single-party majority government could be formed. [v5; v4; v5; v5]
- **Difference between most and second most liked party:** A variable ranging from 0 to 10 that subtracts the approval from the most liked party from the second most liked party. 0 implies that a respondent evaluated both parties equally.
- **Education:** A six-point scale about the level of education. In the regressions reported in the paper is treated as an interval-level variable, but the results remain the same if we treat Education as an ordinal (factor) variable. [vf; vf; vf; vf]
- **Electoral system evaluation:** A dummy variable which asks the respondent whether she likes or dislikes the cumulative electoral system. 1 if the respondent likes the party, 0 if respondent dislikes system, answers ‘don’t know’ or answers ‘do not mind’. [v36; v42; v38; v43]
- **Interest in election:** A four-point variable which asked the respondent for the interest in the Land election ranging from ‘very low’ to ‘very high’. Interested in election is treated as an interval-level variable, but the results remain the same if we treat Interest in election as an ordinal (factor) variable. [v3h; v3h; v3h; v3h]
- **Party affiliation:** A dummy variable that asks whether a respondent feels affiliated to a political party. [vs; vs; vs; vs]
- **Political knowledge:** A dummy variable that captures the knowledge concerning the election. Respondents who could name both the frontrunners of the two leading parties CDU and SPD get the value 1, respondents who did not know the names of both frontrunners are coded as respondents with low political knowledge (0). [v9a, v9b; v9a, v9b; v8a, v8b; v9a, v9b]
- **Relative approval:** A continuous variable ranging from 0 to 10 (in the surveys it ranged from –5 to 5). It measures the difference between the maximum approval and the mean of all other parties evaluated by each respondent. [v7; v7; v7; v7]

Alternative variable specifications

- **Split vote (concrete)**: A dummy variable that takes the value 1 if a respondent named the (two or more) parties she would vote for. If a respondent names only a single party, he is coded as 0. This variable controls for the fact that sometimes respondents reported to split their vote (see variable v3c), but did/wanted/could not name the concrete choice of parties. [v3f; v3f; v3f; v3c; v3f]
- **Relative approval (standardised)**: A continuous variable ranging from 0 to 1. It divided *Relative approval* by the approval score for the most liked party. [v7; v7; v7; v7]
- **Relative approval (positive only)**: Because the original coding of the approval variables ranges from -5 to 5 , as a robustness test we estimate the relative approval using only positive party evaluations and removing the negative ones for each respondent. Relative approval (positive only) can range from 0 to 5. [v5; v4; v5; v5]
- **Political knowledge (SPD candidate only)**: A dummy variable that captures the knowledge concerning the election. Respondents who could name the frontrunner of the SPD get the value 1, respondents who did not know the name are coded as respondents with low political knowledge (0). [v9a; v9a, v9b; v8b; v9a]

E. Links to original survey data sets

- **Bremen 2011**: Forschungsgruppe Wahlen, 2012. State election in Bremen 2011. GESIS Data archive, Cologne. ZA5627 Data file Version 1.0.0. <http://doi.org/10.4232/1.11467>.
- **Hamburg 2011**: Forschungsgruppe Wahlen, 2012. State election in Hamburg 2011. GESIS Data archive, Cologne. ZA5623 Data file Version 1.0.0. <http://doi.org/10.4232/1.11466>.
- **Bremen 2015**: Forschungsgruppe Wahlen, 2016. State election in Bremen 2015. GESIS Data archive, Cologne. ZA6699 Data file Version 1.0.0. <http://doi.org/10.4232/1.12651>.
- **Hamburg 2015**: Forschungsgruppe Wahlen, 2016. State election in Hamburg 2015. GESIS Data archive, Cologne. ZA6698 Data file Version 1.0.0. <http://doi.org/10.4232/1.12650>.