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September 2013

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First Draft: June 2012
This Version: September 2013

Abstract

Social scientists have long speculated about individuals' tendencies to misrepresent their preferences in order to affect the outcome of social choice mechanisms. The fact that preference orderings are generally unobserved, however, has made it very difficult to document strategic behavior empirically. Exploiting the incentive structure of Germany's voting system to solve the fundamental identification problem, this paper estimates the extent of strategic voting in large, real-world elections. The evidence indicates that approximately 35% of voters abandon their most preferred candidate if she is not in contention for victory. As predicted by theory, tactical behavior has a non-trivial impact on individual races. Yet, as one aggregates across districts, these distortions partially offset each other, resulting in considerably more modest effects on the overall distribution of seats.

*I have benefitted from comments by Daron Acemoglu, Scott Ashworth, Gary Becker, Daniel Benjamin, Eric Budish, Ethan Bueno de Mesquita, Dana Chandler, Steve Coate, Tony Cookson, Daniel Diermeier, Will Dobbie, Tim Feddersen, Amy Finkelstein, Alex Frankel, Roland Fryer, Richard Holden, Steven Levitt, Antonio Merlo, Kenneth Mirkin, Francesca Molinari, Roger Myerson, Matthew Notowidigdo, Elisa Olivieri, Nicola Persico, Jesse Shapiro, Jan Stoop, Philipp Tillmann, David Toniatti, Yasutora Watanabe, and Richard Van Weelden, as well as audiences at the AEA Meetings, the Calvó-Armengol Prize Workshop (Barcelona GSE), Columbia, Cornell, the Gaming and Learning in Incentive Systems Conference (Boston University), Kellogg, LSE, MIT, the Princeton Conference on Political Economy, University of Chicago, and Wharton. I am also indebted to Gabriele Schömel at the office of the Bundeswahlleiter for assistance in acquiring the data used in this paper. Steven Castongia, Scott Lin, and Adam Spiegel provided excellent research assistance. Financial support from the Beryl W. Sprinkel Fund is gratefully acknowledged. All views expressed in this paper as well as any remaining errors are solely my responsibility. Correspondence can be addressed to the author at Kellogg School of Management, Northwestern University, 2001 Sheridan Road, Evanston, IL 60208, or by e-mail: j-spenkuch@kellogg.northwestern.edu.

1. Introduction

Democracy is rooted in the conviction that collective choices should be based on the preferences of all members of society. To provide citizens with an opportunity to participate in the decision making process, almost all democratic states rely on elections. Yet, as a mechanism for eliciting and aggregating preferences, elections are known to be flawed (Arrow 1951). Among other theoretical shortcomings, practically every reasonable voting system fails to be strategy-proof (Gibbard 1973; Satterthwaite 1975). As a result, strategic voters may be able to affect the outcome of an election by misrepresenting their true preferences.

Although social scientists have long speculated about individuals' proclivities to cast tactical ballots (e.g., Black 1948; Downs 1957; Duverger 1954; Farquharson 1969; Sen 1970), and despite a plethora of anecdotal evidence, it has proven extremely difficult to document strategic behavior empirically. The key problem is that voters' tastes are generally unobserved. Without imposing further assumptions it is, therefore, impossible to know whether ballots accurately reflect the underlying preference orderings and to what extent tactical voting changes electoral outcomes. In fact, in an important paper Degan and Merlo (2009) prove that *any* cross-section of votes can be rationalized by some utility function, without resorting to strategic behavior.

While there are many ways in which agents could be strategic, this paper focuses on testing one of the central assumptions in social choice theory. According to the theory, individuals behave strategically by choosing someone other than their most preferred candidate whenever the latter is believed to have no chance of winning. Conversely, agents who vote for their favorite contestant regardless of whether she is in contention for victory are said to be sincere.[1]

In order to resolve the fundamental identification problem, the present paper exploits the incentive structure of parliamentary elections in Germany. Under the German system individuals have two votes. Both are submitted simultaneously, but are associated with very different incentives. The *list vote* is cast for a party and counted on the national level. Up to a first-order approximation, list votes determine the distribution of seats in the Bundestag. Since mandates are awarded on a proportional basis (conditional on clearing a 5%-threshold), it is in practically every agent's best interest to reveal his true preferences over which party he wishes to gain the marginal seat by voting for said party.[2]

[1] Naturally, issues of tactical voting do not arise in elections with only two candidates. In such cases even strategic voters simply select their favorite contestant.

[2] Note well, individuals' preferences over which party wins the marginal seat in parliament need not coincide with their deep ideological convictions. Nevertheless, it is useful to think of preferences in this narrowly defined way, as it conditions on expectations about post-election coalition formation, the influence of campaign activities, etc.

By contrast, the *candidate vote* is counted in a first-past-the-post system on the district level. Whoever wins the plurality of votes in a given district is automatically elected to parliament. Votes cast for any other contestant are "lost." Although the candidate vote is primarily used to determine the identity of local representatives, by securing a disproportionate share of districts parties may actually increase their seat totals (see Section 3 for details). Critically, when it comes to choosing among different candidates, voters have a clear incentive to behave tactically. As in all elections under plurality rule, they should *never* vote for their favorite party's nominee if she is known to be "out of the race."

Figure 1 demonstrates how observing the same individuals under both electoral regimes facilitates identification. For the sake of illustration, suppose that candidates are perfect representatives of their parties and that it is known a priori who has a realistic chance of winning. First, entertain the possibility that all voters cast sincere ballots. As shown in the panels on the left, if this were indeed the case, there would be a one-to-one correspondence between list and candidate votes—irrespective of whether the particular candidate is a contender.

Next, assume that all voters behave tactically. In such a world only candidates who are believed to be in contention for victory should receive any votes. Thus, for non-contenders the curve representing the relationship between list and candidate votes ought to be perfectly flat.[3]

Lastly, consider the case in which there are both sincere and strategic types. As before, sincere agents vote for their preferred candidate, but no tactical type chooses a non-contender. Consequently, the line relating non-contenders' share of the candidate vote to their parties' list votes must have a slope between zero and one. It is this slope that identifies the fraction of voters who are sincere.

Of course, not all candidates are perfect representatives of their parties—despite the fact that party platforms are much more salient in Germany than in the U.S. Some candidates are more charismatic, better qualified, or have a higher media profile than others. Supporters of rival parties might, therefore, be "drawn in" by a candidate's personal appeal. Conditional on being out of the race, however, theory predicts that even high valence contestants will be deserted by all of their strategic supporters. Hence, after carefully controlling for candidate quality, the partial correlation between non-contenders' list and candidate votes continues to measure the fraction of agents who stick with their preferred contestant despite her being "out of the race."[4]

[3]Strictly speaking, the shape of the curve for contenders is indeterminate. While it has to lie weakly above the origin and must end at $(100\%, 100\%)$, the slope at intermediate points will generally depend on the correlation of preferences. If, however, tastes are approximately uncorrelated within precincts, then one would expect an almost one-to-one relationship between list and candidate votes.

[4]Naturally, there exist more elaborate models in which voters are reluctant to abandon high valence candidates. Empirically, however, there is no evidence that this is the case. If anything, there is a small

To account for heterogeneity across candidates this paper uses previously unavailable precinct level data from the 2005 and 2009 federal elections. In Germany, precincts are the smallest administrative units at which votes are counted, and each precinct is fully contained within one electoral district. Since races take place at the district level, these data allow for the slopes in Figure 1 to be estimated from within-candidate variation only, thereby *conditioning* on the characteristics of candidates and their competitors, beliefs about pivot probabilities, etc.

Figure 2 provides an empirical example from the 2009 election in District 207. Each panel plots a candidate's own vote share against her party's share of the list vote in the same precinct. In contrast to the contestants in the top row, those in the bottom two rows were widely believed to have no chance of winning. As one would expect if list votes were a good proxy for individuals' preferences, after allowing for candidate specific intercepts there is an almost one-to-one relationship between list and candidate votes for contenders. Non-contenders, however, are deserted by a significant number of supporters.

An important remaining obstacle is that it is often unknown which candidates were considered to be "in the race." If voters had perfect foresight then only an election's winner and runner-up should have been expected to be in contention for victory. In reality, however, voters are likely to have noisy priors and may consider more than just two candidates to be serious contenders. Reassuringly, the main findings are qualitatively and quantitatively robust to more than twenty-five alternative ways of classifying contestants.

Thus, irrespective of how agents are ultimately assumed to form beliefs about which candidates are in contention for victory, the results in this paper show that approximately 35% of voters abandon their most preferred candidate if she is believed to have no chance of winning. Two key pieces of evidence indicate that defection is, in fact, driven by strategic considerations. First, not only do individuals who abandon their favorite contestant substitute toward the nominee of a potential coalition partner, but desertion rates themselves are much higher among voters faced with at least one palatable alternative than among those who can only choose among two evils. Second, estimates of strategic voting are substantially larger for elections perceived as "critical" than for ordinary ones. Alternative explanations, such as agents receiving utility from supporting the eventual winner of the election, are rejected by the data.

Counterfactual election results demonstrate that in the absence of any strategic behavior about one in ten districts would change hands. However, as one aggregates across districts, these "distortions" partially offset each other, resulting in only modest effects on the overall

negative correlation between the measured quality of a contestant and the fraction of voters who abandon her.

distribution of seats.

The results in this paper speak directly to large theoretical literatures on tactical voting (e.g., Austen-Smith and Banks 1988; Carroll 2011; Cox 1994; Feddersen and Pesendorfer 1996; Myatt 2007, 2012; Myerson 2002; Myerson and Weber 1993) and strategyproofness in social choice (see Barberà 2011 for a recent review). On a purely descriptive level, the empirical evidence indicates that the fundamental prediction in rational choice studies of voting holds for some, but by no means all, individuals. The evidence also suggests that it is important to distinguish the impact of strategic voting on a given race from its effect on seat totals.

Moreover, the findings presented below may aid in the formulation of political economy models. Often, these models require an *assumption* regarding the voting behavior of agents, and the conclusion may depend critically on whether voters are taken to be tactical or sincere (compare, for instance, Besley and Coate 1997 with Osborne and Slivinski 1996

The remainder of the paper proceeds as follows. The next section offers a brief review of the existing empirical literature. Section 3 outlines the crucial features of Germany's electoral system. Section 4 introduces a formal model of sincere and strategic voting, and Section 5 provides a first look at the data. The main results appear in Section 6. Section 7 presents counterfactual experiments to analyze the impact of strategic behavior. The last section concludes.[5]

2. Previous Literature

There exists a large empirical literature on strategic voting and turnout. While laboratory experiments provide generally convincing evidence of tactical behavior (e.g., Duffy and Tavits 2008; Eckel and Holt 1989; Forsythe et al. 1993, 1996), real-world results tend to be mixed.

Coate et al. (2008), for instance, reject the pivotal voter model based on the finding that it is unable to replicate winning margins in Texas liquor referenda. Reed (1990) and Cox (1994), however, argue that the distribution of votes in Japan's multimember districts conforms roughly to the predictions of rational choice theory. More recently, Fujiwara (2011) uses a sharp regression discontinuity in Brazilian mayoral elections to show that third-place candidates are more likely to be deserted in races under simple plurality rule than in runoff elections. The most comprehensive study to date is Cox (1997). His findings are suggestive of strategic behavior in a number of electoral systems, but indicate a lack thereof in others.

[5]There are four appendices. Appendix A explains the algorithm for calculating each party's number of seats in the Bundestag. Appendix B presents a simple model of voting under plurality rule to clarify in which sense agents can be expected to cast sincere list votes, and Appendix C contains a formal proof omitted from the body of the paper. Lastly, precise definitions of all variables used throughout the analysis appear in Appendix D.

Even less is known about the *extent* of tactical voting. Two notable exceptions are Spenkuch (2013) as well as Kawai and Watanabe (2013). Spenkuch (2013) exploits a highly unusual by-election in Germany, which allowed a party to gain one seat by receiving *fewer* votes, to derive a 9% lower bound. Kawai and Watanabe (2013) estimate a structural model of voting decisions in Japan's general election, concluding that between 63% and 85% of voters are strategic. Their counterfactual experiments suggest that tactical voting had a significant impact on the distribution of seats.

Recall, the fundamental difficulty in inferring strategic behavior from naturally occurring variation is that voters' preferences are not observed. Thus, any conclusions must either be based on indirect tests (as in Coate et al. 2008; Cox 1997; Fujiwara 2011; Spenkuch 2013), or preferences need to be estimated in order to compare them to actual vote counts (as in Kawai and Watanabe 2013).

A separate strand of the literature tries to circumvent this problem by using survey data on voting decisions and political orientations (see, e.g., Abramson et al. 1992; Blais et al. 2001; Kiewiet 2013; Niemi et al. 1993; or, for Germany, Gschwend 2007; Pappi and Thurner 2002). Estimates in this tradition are typically very low. Wright (1990, 1992), however, points to important survey biases and raises serious doubts about conclusions based on self-reported votes. Alvarez and Nagler (2000) even show that, depending on the survey design, estimates of strategic voting differ by as much as a factor of seven.

3. Germany's Electoral System

In order to shed light on the prevalence of strategic voting, the present paper exploits the structure of parliamentary elections in Germany. Elections to the Bundestag are held according to a mixed member system with approximately proportional representation. Except for minor modifications, the same system has been in place since 1953.[6]

As mentioned in the introduction, each voter casts two different votes (see Figure A.1 in the Appendix for a sample ballot). The first vote, or *candidate vote* (Erststimme), is used to elect a constituency representative in each of 299 single-member districts. The second vote, or *list vote* (Zweitstimme), is cast for a party and counted on the national level.

District representatives are determined in a first-past-the-post system. That is, whichever contestant achieves the plurality of candidate votes in a given district is automatically awarded a seat in the legislature. Winners are said to hold *direct mandates*, and votes cast for any other candidate are discarded.

Figure 4 shows the party affiliation of all district winners in the 2005 and 2009 elections. Although the CDU/CSU secured the majority of direct mandates in both years, there remains

[6]In describing the German electoral system this section borrows from Spenkuch (2013).

ample geographic variation, as well as some variation over time. Of the five major parties only the FDP did not win any districts—despite gaining a non-trivial fraction of votes.[7]

To still achieve approximately proportional representation of all parties clearing a 5%-threshold, the German electoral system also awards *list mandates*. First, all list votes are aggregated up to the national level and a total of 598 preliminary seats are distributed to parties on a proportional basis. Each party's allotment is then broken down to the state level, and compared to its number of direct mandates in the same state. Whichever number is greater determines how many seats the party will actually receive.

More formally, let $d_{p,s}$ denote the number of districts that party p won in state s, and let $l_{p,s}$ be how many mandates it would have received in the same state under proportional representation. Then, the final number of seats that p retains in s equals

$$n_{p,s} = \max\{d_{p,s}, l_{p,s}\},$$

and its total in the Bundestag is given by $n_p = \sum_s n_{p,s}$ (see Appendix A for a detailed description of the algorithm used to allocate seats).

If $d_{p,s} < l_{p,s}$, then in addition to the district winners the first $l_{p,s} - d_{p,s}$ candidates on p's list are elected as well. Otherwise, only holders of direct mandates receive a seat. Parties are said to win *overhang mandates* (Überhangmandate) whenever $d_{p,s} > l_{p,s}$. In such cases the total number of seats in the Bundestag increases beyond 598. Note, however, the total number of mandates awarded under proportional representation, i.e. $\sum_p \sum_s l_{p,s}$, exceeds the number of districts, $\sum_p \sum_s d_{p,s}$, by a factor of two. Thus, situations in which $d_{p,s} > l_{p,s}$ are fairly rare. Consequently, the list vote determines the overall distribution of seats up to a first-order approximation.[8]

Critical for the purposes of this paper are the incentives associated with each vote. First, consider the list vote. Due to the fact that seat totals are approximately proportional to parties' vote shares and given that it is nearly impossible to predict rounding, most agents can be expected to choose their "preferred" party, defined as the one they would like to win the marginal seat in parliament (conditional on their expectations regarding post-election coalition formation, etc.).

Using this definition of preferences, it is easy to see that voting for one's preferred party is a strictly dominant action whenever $\mathbb{E}[d_{p,s}] < \mathbb{E}[l_{p,s}]$. Only if one anticipates that $d_{p,s} > l_{p,s}$ may it not be optimal to do so. However, most voters cannot reasonably assign a high prob-

[7] Since the introduction of the two-ballot system in 1953 no independent candidate has ever won a district.

[8] Theoretically, overhang mandates may lead to departures from proportionality of up to one third of all seats. In the current equilibrium, deviations are much smaller. For instance, relative to its share of the list vote, the CDU/CSU received an additional 7 mandates in 2005, whereas the SPD secured 9 extra seats.

ability to this event. Historically, it occurred for less than 10% of state-party combinations, and FDP, Greens, as well as The Left have never won any overhang mandates. The vast majority of individuals has, therefore, an ex ante incentive to cast truthful list votes.[9]

When it comes to the candidate vote, however, agents have a clear incentive to behave tactically—as in all elections under plurality rule. If their preferred candidate is known to be "out of the race," then one can *always* do strictly better by voting for somebody else. Substituting toward a contestant who actually has a chance of winning could benefit a coalition partner, or it might spoil a particularly disliked party's victory. Even if voters took the aggregate distribution of seats as given, by casting tactical ballots they can elect "better" local representatives. Although expected payoffs may not be large, as long as individuals are not completely indifferent to who carries their district, they should *never* waste their vote on a candidate who is "out of the race."[10]

4. A Model of Sincere and Strategic Voting

In order to formalize this intuition and frame the empirical work to follow, this section introduces a simple model of voting under plurality rule. Instead of considering the complete decision problem associated with list and candidate votes in Germany, it is more useful to focus on the race for a direct mandate in one electoral district, i.e. on a single *subgame*. The model is a straightforward extension of Myerson and Weber (1993) with the addition of sincere voters, stochastic turnout, and endogenous pivot probabilities.[11]

4.1. *Basic Building Blocks*

Let the set of candidates be denoted by $K = \{1, 2, \ldots, k\}$. Members of the electorate (simultaneously) cast single nontransferable votes, and the contestant with the highest vote total is declared the winner of the election. Ties are broken by the flip of a fair coin.

Voters are either sincere or tactical, $\theta \in \{s, t\}$. Sincere voters always choose their most preferred candidate, whereas tactical agents act based on personal preferences as well as their beliefs about the actions of other players in the game. The share of agents who are sincere is given by $\lambda \in [0, 1]$.

Each voter has strict preferences over candidates summarized by a vector $u = (u_1, \ldots, u_k)$ in some finite set $U \subset \mathbb{R}^k$, where u_i is the expected utility from candidate i winning the

[9]The results in this paper are qualitatively and quantitatively robust to focusing on state-party combinantions for which $d_{p,s} \leq l_{p,s}$ (see Section 6.3).

[10]At first, the German system may seem very complicated. Yet, the results of Spenkuch (2013) show that voters are keenly aware of the incentives at work.

[11]Appendix B presents a simple model of voting in the plurality rule part of the German system, and clarifies in which sense agents can be expected to cast sincere list votes.

district (conditional on the expected outcomes in all other districts as well as the expected realization of the national list vote). $f(u)$ denotes the fraction of individuals with a particular preference profile. That is, f is a probability distribution over U. A voter's type is defined as the tuple $(u, \theta) \in \mathcal{I} \equiv U \times \{s, t\}$. For simplicity, u and θ are assumed to be independent random variables.

Agents know their own type, but are uncertain about the number of other players in the game. This captures the idea that real world elections are characterized by substantial uncertainty about turnout, and that voters are typically not aware of everybody else's identity. Following Myerson (1998, 2000), assume that the total number of voters is a random variable drawn from a Poisson distribution with mean $n < \infty$. n, f, as well as λ are common knowledge.[12]

As mentioned above, strategic agents maximize expected utility taking the behavior of others into account. More specifically, tactical voters choose candidate k only if doing so maximizes

$$(1) \qquad \overline{u}\left(k, \widetilde{\pi} | u, t\right) = \frac{1}{2} \sum_{k' \in K \setminus \{k\}} \widetilde{\pi}(k, k') \left[u_k - u_{k'}\right],$$

where $\widetilde{\pi} = \left(\widetilde{\pi}\left(k, k'\right)\right)_{k,k' \in K}$ denotes players' common beliefs about the probability of casting a pivotal vote.[13]

By contrast, sincere players always select their most preferred contestant. They maximize the utility function:

$$\overline{u}\left(k, \widetilde{\pi} | u, s\right) = u_k.$$

4.2. *Equilibrium*

Let $\sigma\left(k|u, \theta\right)$ denote voters' strategies. That is, $\sigma : \mathcal{I} \to \Delta\left(K\right)$ specifies the probability that a type (u, θ) voter casts a ballot for candidate k. In equilibrium it must be the case that, for all $(u, \theta) \in \mathcal{I}$,

$$\sigma\left(k|u, \theta\right) > 0 \quad \text{only if} \quad k \in \arg\max_{k' \in K} \overline{u}\left(k, \widetilde{\pi} | u, \theta\right).$$

[12]The Poisson assumption is made for convenience. None of the empirical results depend on it. For a mathematically more rigorous model of strategic voting see Palfrey (1989).

[13]To see that (1) follows from expected utility maximization note that an individual's vote affects his payoff only if it changes the outcome of the election, i.e. if two candidates are either tied for first or one vote apart. If candidate k and k' are tied, then voting for the former results in an expected utility gain of $u_k - \frac{1}{2}\left(u_k + u_{k'}\right)$. If k is one vote behind k', then choosing k changes payoffs by $\frac{1}{2}\left(u_k + u_{k'}\right) - u_{k'}$, which is the same as the previous expression. Summing over all candidate pairs and weighting by $\widetilde{\pi}$ gives (1).

Given σ, realized vote totals, $v = (v(k))_{k\in K}$, are random variables with means, $\mu = (\mu(k))_{k\in K}$, equal to

$$\mu(k) = n\sum_{u\in U}\left[\lambda\sigma(k|u,s) + (1-\lambda)\sigma(k|u,t)\right]f(u). \tag{2}$$

From the Poisson assumption it follows that the elements of v are independently distributed (see Myerson 1998 for a proof), which allows the probability of casting the pivotal vote to be expressed in a transparent way. More specifically, not knowing the exact number of players in the game, the ex ante probability of candidate k being tied for first or one vote behind k' is given by

$$\pi(k,k') = \sum_{\tau=1}^{\infty}\left[\psi(v=\tau|\mu(k))\left(\sum_{\tau'=\tau}^{\tau+1}\psi(v=\tau'|\mu(k'))\right)\left(\prod_{k''\in K\setminus\{k,k'\}}\sum_{\tau''=0}^{\tau-1}\psi(v=\tau''|\mu(k''))\right)\right],$$

where $\psi(v=\tau|\mu(k))$ denotes the probability of a Poisson random variable v with parameter $\mu(k)$ being equal to τ.[14]

DEFINITION: Given the Poisson game $\Gamma(K,\mathcal{I},n,f,\lambda)$, a *voting equilibrium* consists of a *strategy function* σ satisfying, for all $(u,\theta)\in\mathcal{I}$,

(i) $\sigma(k|u,\theta)\geq 0 \quad \forall k\in K$,

(ii) $\sum_{k\in K}\sigma(k|u,\theta) = 1$, and

(iii) $\sigma(k|u,\theta) > 0$ only if $k\in\arg\max_{k'\in K}\overline{u}(k',\widetilde{\pi}|u,\theta)$;

as well as a set of *beliefs* such that

(iv) $\widetilde{\pi}(k,k') = \pi(k,k') \quad \forall k,k'\in K$.

PROPOSITION 1: *The set of voting equilibria is always non-empty.*

PROOF: See Appendix C.

To get a sense of what equilibrium play looks like note that strategic voters' utility function is homogenous in $\widetilde{\pi}$. Hence, tactical voting decisions are determined by the relative—not absolute—size of perceived pivot probabilities. From the magnitude theorem in Myerson (2000) it follows that some pivot probabilities are going to be several orders of magnitude larger than others; although for large electorates all elements of π will be very close to zero. That is, as $n\to\infty$ most pivot probabilities become infinitesimal relative to, at most, a few

[14] As is typical in the literature on strategic voting, the probability of three-way ties is assumed to be negligible.

remaining ones. Intuitively, this is because homogeneity of the utility function implies that $\widetilde{\pi}(k, k')$ can be rewritten as the probability of k and k' running neck-and-neck ahead of all other contestants, *conditional* on the election being tied in the first place. Such a tie, however, is substantially more likely to involve the two front-runners than an underdog. Hence, almost all of the probability mass must be concentrated in one or two candidate pairs, which gives rise to the following corollary.

COROLLARY: *In large elections only a subset of candidates will be "in the race," and strategic voters behave as if choosing only among those candidates who are believed to be serious contenders.*

Since tactical agents become more inclined to select a particular candidate as they form favorable beliefs about her being in contention for victory—say, because her standing in pre-election polls improves, or due to campaign activities that manipulate voters' perception of candidate viability—the model above exhibits the potential for *bandwagon effects* and *self-fulfilling prophecies* (Simon 1954). In general there may be multiple equilibria, and any candidate that is not a Condorcet loser may be the sole likely winner under plurality rule (cf. Myerson and Weber 1993). Thus, without further refinement the model makes no prediction about the set of candidates who will be "in the race," i.e. which of the possible equilibria is being observed by the econometrician.

4.3. *Mapping Theory into Data*

For identifying the share of strategic voters, however, this is less of a problem than it may seem. The key takeaway from the discussion above is that it is not optimal for strategic agents to vote for a candidate who is "out of the race," i.e. for whom tie probabilities are orders of magnitude smaller than for other candidates. It must, therefore, be the case that $\sigma(k|u,t) = 0$ for all candidates who are "non-contenders," whereas $\sigma(k|u,s)$ equals either 0 or 1, depending on whether type (u,s) agents prefer k over every other contestant. Given these strategies and focusing on candidates believed to be "out of the race," equation (2) simplifies to

$$\mu(k)/n = \lambda \sum_{\widetilde{u} \in \{u \in U | u_k > u_{k'} \forall k'\}} f(\widetilde{u}).$$

The left-hand side of this expression denotes k's share of the candidate vote, whereas the right-hand side equals the share of strategic voters multiplied by the fraction of agents who favor k.

Thus, if one can find a subset of candidates who voters must have believed to be out of the race *given* the equilibrium being played, and if one accepts the assumption that list votes are not only a (potentially noisy) measure of voters' preferences over parties, but also a proxy for the fraction of individuals who favor the respective nominees, i.e. for $\sum_{\widetilde{u}} f(\widetilde{u})$, then λ can be identified from the candidate-list vote gradient among these non-contenders. Of course, for the latter assumption to be reasonable it is important to properly account for systematic differences in candidates' idiosyncratic appeal.

5. A First Look at the Data

5.1. *Data Sources and Descriptive Statistics*

Before doing so it is useful to get a sense of the broad patterns in the data. Table 1 shows aggregate frequencies of different list and candidate vote combinations in the 2009 federal election.[15] First and foremost, the evidence suggests that some, but not all voters desert weak candidates. Although nominees of FDP, Greens, and other minor parties are rarely in contention for victory, they are abandoned by only about half of their followers. At the same time, the numbers show that, conditional on abandoning their own party's candidate, about 83% of all FDP supporters voted for a contestant of the CDU—its coalition partner—whereas 72% of Green Party adherents chose an SPD nominee. It, therefore, appears that voters who do desert non-contenders substitute toward close political allies.

Though indicative of strategic voting, Table 1 is ultimately insufficient to determine its extent. For instance, some FDP supporters might have chosen CDU candidates not because of tactical considerations, but because they are better qualified or more charismatic. Also, not all CDU and SPD adherents voted for their own party's nominee. In fact, almost one third of those who deviate end up picking a political rival. While it is possible that these voters chose among the lesser of two evils in districts in which the CDU or the SPD candidate happened to be "out of the race," it is also plausible that their voting decisions were solely based on candidate idiosyncrasies.

In fact, the descriptive statistics in Table 2A demonstrate that candidates differ along important dimensions.[16] For instance, only 19% of CDU candidates are female, compared to 35% of Social Democrats and 34% of Green Party nominees. Moreover, relative to their FDP, Left, or Green Party counterparts, contestants of CDU and SPD are about four times more likely to be a current member of parliament, and more than forty times as likely to

[15]Table 1 is based on a 3.9% random sample of actual votes. German electoral law requires the Federal Returning Officer to publish descriptive statistics on vote combinations, as well as voting behavior by age and gender (see Bundeswahlleiter 2010). Unfortunately, the micro-data are not publicly accessible.

[16]The information in Table 2B has been compiled from official publications by the Federal Returning Officer (Bundeswahlleiter 2005c, 2009b).

be an incumbent. Therefore, any argument linking differences in the distribution of list and candidate votes to strategic behavior must be based on an econometric strategy that carefully controls for candidates' idiosyncratic appeal.

To this end, the present paper relies on official election results by polling precinct (Wahlbezirk). These data have been obtained from the Federal Returning Officer and were until recently not publicly available. In Germany, precincts are the smallest administrative units at which votes are counted. Each precinct is fully contained within an electoral district and associated with one polling station where a returning officer oversees the election. By law, no precinct can contain more than 2,500 eligible voters. As of 2009 there were 299 electoral districts and almost 89,000 precincts. Since races take place at the level of the electoral district, precinct level data allow for λ to be estimated from within-candidate variation only, thereby *conditioning* on all observable as well as unobservable characteristics of candidates and their competitors, beliefs about tie probabilities, etc.

In order to ensure that list votes are, indeed, a reasonable proxy for individuals' preferences the main part of the analysis focuses on Germany's five major parties and on the 2005 and 2009 federal elections. In these years all important parties were widely expected to clear the 5%-threshold.[17] Since voters could be virtually certain that their preferred party would be represented in parliament, list votes should reflect preferences more accurately in 2005 and 2009 than in prior years.

Differentiating between East and West Germany as well as election year, Table 2B displays summary statistics for all precinct level variables. Compared to the U.S., turnout is fairly high. Averaging across 2005 and 2009, almost 75% of the electorate went to the polls. Together with an average size of 821 eligible voters, this means that precincts handle about 615 votes. As is well known, CDU, SPD, FDP, and the Green Party fare substantially better in West Germany than in the East. The opposite is true for The Left—the successor of the East German communist party. Moreover, CDU and SPD receive more candidate than list votes. Since nominees of these two parties are serious contenders in most districts, one would expect such a "surplus" of candidate votes if voters were, indeed, behaving strategically.

5.2. *Testing the Null Hypothesis of Sincere Voting*

Following the argument in the introduction, it is straightforward to test the null hypothesis of no strategic voting. If all individuals cast sincere list *and* sincere candidate votes, then after controlling for nominees' idiosyncratic appeal there ought to be a one-to-one relationship

[17]For instance, more than 90% of adults sampled in the 2009 pre-election survey of the German Longitudinal Election Study (GLES) expected the FDP and Green Party to receive more than five percent of the list vote.

between the two. That is, on the margin an extra list vote should translate into an additional vote for the nominee of the respective party.

The results in Table 3 show that this is not the case. The ordinary least squares estimates therein correspond to the econometric model

$$v^C_{k,r,t} = \chi_{m,k,t} + \phi v^L_{k,r,t} + \epsilon_{k,r,t}, \tag{3}$$

where $v^C_{k,r,t}$ denotes contestant k's share of the candidate vote in precinct r during election year t, and $v^L_{k,r,t}$ is her party's share of the list vote in the same precinct. To allow for arbitrary forms of autocorrelation in the residuals as well as for correlation within and across districts, standard errors are clustered by state. Going from the left of the table to the right the set of fixed effects grows steadily. The most inclusive specification contains $\chi_{m,k,t}$, a municipality and year specific candidate fixed effect. It, therefore, controls nonparametrically for the appeal of individual candidates (and that of their competitors) as perceived by the voters in a given town or village.[18]

Using this model one can dismiss the null of sincere voting if it is possible to reject $H_0 : \phi = 1$. Clearly, in all specifications that control for candidates' idiosyncrasies the slope between list and candidate votes is considerably smaller than one. And given the precision of the estimates in columns (3)–(5) the null is rejected at the .01%-significance level.

Of course, all hypothesis tests are joint tests of the null *and* the identifying assumptions. In principle, rejection of H_0 could be due to voters' preferences over parties and candidates being completely uncorrelated, or to list votes being only a very noisy proxy for which candidates agents prefer (causing attenuation bias).

To rule out this possibility consider Figure 4. Restricting attention to the eventual winner and runner-up of each race the figure displays a semi-parametric estimate of the relationship between list and candidate votes, i.e. $f(\cdot)$ in

$$v^C_{k,r,t} = \chi_{m,k,t} + f\left(v^L_{k,r,t}\right) + \epsilon_{k,r,t}. \tag{4}$$

If the identifying assumption does, indeed, hold, then for this set of candidates there ought to be a one-to-one correspondence between both votes irrespective of whether agents behave strategically. After all, surprises in large scale elections are very rare, and voters have no incentive to desert someone they should have believed to be in contention for victory. Conversely, seeing a slope smaller than unity even for contenders should lead one to question the assumption that list votes are informative of individuals' preferences over candidates.

[18] There are usually multiple precincts per municipality, which allows for straightforward identification of $\chi_{m,k,t}$.

Fortunately, Figure 4 provides no indication that this is warranted. On the contrary, there is an almost one-to-one relationship between list and candidate votes for contenders, and over most of the range the standard error bands are tight enough to rule out meaningful deviations from the 45-degree line.[19] Based on this evidence one would have to conclude that list votes provide an excellent proxy for whom individuals would vote if their preferred candidate was still "in the race." Consequently, failure of the identifying assumptions is unlikely to cause the rejection of the null hypothesis of sincere voting.

6. Estimating the Extent of Strategic Voting

6.1. *Econometric Approach*

Although it is important to reject the possibility that all agents act sincerely, the evidence presented above does not speak to the *prevalence* of strategic voting. In order to estimate its extent this paper pursues two related empirical strategies.

The first strategy follows the argument in Section 4.3 and identifies the fraction of sincere agents from candidates who were clearly not in contention for victory. This approach only requires that conditional on the equilibrium being observed by the econometrician one can find a subset of nominees who voters must have believed to be "out of the race." For this set of candidates one then estimates

$$v^C_{k,r,t} = \chi_{m,k,t} + \lambda v^L_{k,r,t} + \epsilon_{k,r,t}, \tag{5}$$

where all symbols are as defined above.

As long as there is no heterogeneity in the extent of strategic voting it is irrelevant if the set of included candidates is chosen too conservatively, i.e. if one discards some candidates who were also believed to be "out of the race." Settling on a too narrowly defined set of non-contenders will only come at a loss of statistical power, but it will not prevent consistent estimation of λ, the parameter of interest.

If, however, there is heterogeneity in λ *and* if this heterogeneity is systematically correlated with who remains in contention for victory, then restricting attention to candidates who trail far behind might lead to biased estimates. The second (and, therefore, preferred) empirical strategy addresses this problem by adopting a data driven approach to classifying contestants.[20]

[19] Estimating ϕ for this set of candidates by ordinary least squares results in point estimate of .989 with a standard error of .018 if muncipality-candiate-year fixed effects are included, and 1.021 (.011) if candiate-year fixed effects are used instead.

[20] Unfortunately, pre-election surveys in Germany are too small to derive reliable estimates of voters' expectations. For instance, in only 50 electoral districts did the German Longitudinal Election Study (GLES)—the best available data source—survey more than 15 adults prior to the 2009 elections.

To see that the data itself are highly predictive of which candidates end up competing for a direct mandate consider Table 4, which shows a cross-tabulation of candidates' own rank (based on the candidate vote) against the standing of their party among voters in the same district (based on the list vote). Out of the 598 contestants whose party placed first, only 41 did not win a direct mandate and a mere 2 finished third or worse. In contrast, none of the candidates who ran for a party ranked fourth or below came in first, and only 3 finished second. Overall, the correlation between list and candidate vote based rank is .93. The evidence, therefore, suggests that voters coordinate on the nominees of the district's most popular parties.

If one believes that agents do, indeed, play focal equilibria of this type, then contestants backed by one of a district's two favored parties should be considered serious contenders, whereas candidates of parties ranked fourth and below are "out of the race." The only ambiguity arises with respect to those in third place. In practice, almost 10% of third ranked contestants finish first or second. Hence, one would want to classify some (but not all) of them as contenders, especially in cases in which only a few percentage points separate their own party from the one in second place.

Drawing from the literature on structural breaks in time series data, it is possible to estimate a cutoff value, κ, separating candidates into contenders and non-contenders. More specifically, the second empirical strategy classifies candidate k as a contender if, and only if, her party trails a district's second most popular one by less than κ percentage points.

With this definition in hand, the estimating equation becomes

$$v^C_{k,r,t} = \chi_{m,k,t} + \lambda v^L_{k,r,t} \times \mathbf{1}\left[\overline{v}^{L,2^{nd}}_{d,t} - \overline{v}^L_{k,d,t} > \kappa\right] + \gamma v^L_{k,r,t} \times \mathbf{1}\left[\overline{v}^{L,2^{nd}}_{d,t} - \overline{v}^L_{k,d,t} \leq \kappa\right] + \epsilon_{k,r,t}. \tag{6}$$

Here, $\overline{v}^L_{k,d,t}$ denotes the list vote share of candidate k's party in district d, and $\overline{v}^{L,2^{nd}}_{d,t}$ is that of the second most popular party in the same district.

If (6) is correctly specified, then searching for the value of κ that maximizes the R^2 yields a super-consistent estimate of the true break point (Hansen 2000). Moreover, under the null hypothesis that such a point exists, estimates of the model's other parameters are normally distributed and standard errors need not be adjusted for sampling variability in the location of the break (see, e.g., Bai 1997).

Although intuitively appealing, there is no guarantee that this method classifies all candidates correctly. For this reason Section 6.3 performs a series of robustness checks, demonstrating that results are qualitatively and quantitatively robust to more than 25 alternative assumptions on how voters form beliefs about which candidates are in contention for victory.

6.2. *Main Results*

Focusing on nominees of the five major parties, Table 5 displays the main results. The upper panel follows the first empirical strategy and restricts the sample to candidates who trailed the runner-up by more than 10 percentage points, whereas the lower one implements the second approach.

The first row within each panel presents estimates of the share of voters who stick with their preferred candidate despite her having no chance of winning. Controlling for the idiosyncrasies of candidates and their competitors, estimates of λ range from .613 to .657, and are fairly precise. Moreover, it is worth noting that the evidence from both empirical approaches lines up very well. Despite small standard errors, estimates from the first and second approach are statistically indistinguishable. Taken at face value, the results indicate that slightly less than two thirds of voters are sincere, whereas the remaining third abandons their favorite contestant whenever she is "out of the race."

The crucial question, however, is whether voters do so for strategic reasons. Strictly speaking, any model would be consistent with the evidence in Table 5 as long as it predicts the candidate-list vote gradient for non-contenders to be smaller than one. For instance, some individuals may simply vote for whichever candidate advertises the most, and advertising expenditures might be highly correlated with who remains in contention for victory. It would, therefore, appear as if voters abandon weak candidates, despite the fact that no agent behaves tactically.

In order to rule out mechanical explanations of this kind, Table 6 compares the extent of strategic voting, i.e. $1 - \lambda$, across a number of different settings. The first set of results demonstrates that individuals' tendency to desert weak contestants depends on *who* remains in contention for victory. Voters are about three times as likely to abandon their favorite candidate when that of an allied party is still "in the race" than when faced with the choice among two evils.[21]

Moreover, distinguishing between races that were "close" and those that were not, strategic voting appears to have been somewhat more prevalent in the former—although the difference is not statistically significant; and disaggregating the data by election year shows that desertion of non-contenders was more common in 2005 than in 2009. The 2005 election followed a failed motion of confidence that triggered the dissolution of the Bundestag and was widely perceived to be a "critical election" (Korte 2009).[22] It is, therefore, hardly surprising that a

[21]The following parties are defined as close substitutes: CDU and FDP, SPD and Green Party, The Left and SPD. The difference in Table 6 is even starker when supporters of The Left are assumed to have no substitute available.

[22]Campaigning to stay in office, Chancellor Schröder and his SPD-Green coalition promised to undo some of their unpopular labor market and welfare reforms, while raising taxes on the rich. In stark contrast,

greater number of voters behaved tactically when the stakes were particularly high.[23]

Taken together, these findings suggest that it might be more appropriate to consider strategic behavior a conscious decision as opposed to an agent's type. That is, all agents may be capable of voting tactically, but only for a subset of them do the subjective benefits outweigh the (psychic) costs. In such a richer model λ would not refer to the population share of strategic types, but to the fraction of voters whose psychic cost are below the endogenously determined cut-off value.

More importantly, the evidence in Table 6 is at odds with many alternative theories for why voters abandon candidates who are "out of the race." Any model in which voters defect candidates for non-strategic reasons would not only have to predict a correlation between desertion rates and a contestant's chance of winning, but it would also have to explain why defection is more common when the stakes are higher, and why it depends on who remains in contention for victory. The patterns in Table 6 as well as the fact that voters who do cast split-tickets substitute toward candidates of a potential coalition partner (cf. Table 1) suggest that the observed behavior is, in fact, driven by strategic considerations.

In order to strengthen this claim, Table 7 provides an explicit test of the pivotal voter model against the alternative that individuals receive utility from voting for the eventual winner of the election. The entries correspond to the candidate-list vote gradient among second ranked candidates, by distance to the first ranked one. If agents did, indeed, have a taste for supporting the likely winner, then one would expect runner-ups to be abandoned as well, especially those that trail far behind. By contrast, the model in Section 4 predicts that voters do *not* abandon the runner-up, even if her chances of winning are very small. This is because if a race were to be tied—however unlikely that may be—the tie would almost certainly involve the second ranked candidate, in which case voting for her would change the outcome of the election. Although counterintuitive, the evidence in Table 7 does support the pivotal voter model.

6.3. *Sensitivity and Robustness Checks*

Misclassification of Contenders For the main results to correctly identify the shares of each type of voter it must be the case that the regressors are uncorrelated with the error term. One obvious source of bias may be systematic misclassification of contenders. While it is unproblematic to falsely classify some candidates who voters believed to be "out of

led by Angela Merkel, the conservative-libertarian bloc sought to further increase the pace and scope of deregulation, slashing income taxes and public spending in the process.

[23]Official statistics analogous to those in Table 1 show a substantially higher fraction of split tickets in 2005 (cf. Bundeswahlleiter 2006, 2010). Although abstention was approximately 7 percentage points lower than in 2009, the difference in turnout alone is too small to account for the finding in Table 6.

the race" as contenders, making the opposite mistake would lead to upward bias in λ, and therefore to an understatement of the extent of strategic voting. To ameliorate this concern, Table 8 presents estimates of the share of strategic agents employing more than twenty-five alternative definitions of contenders (listed in the column on the left). For each definition, the table shows two estimates: one based on candidate-year fixed effects, and another one using candidate-year fixed effects that are specific to individual municipalities. For comparison, the top row displays the main results from the lower panel of Table 5.

Although individual point estimates do, of course, vary, the majority of them are very close to their baseline values. For instance, assuming that agents have perfect foresight, one would estimate the fraction of strategic agents to equal 33.7% instead of 34.4%, whereas adaptive expectations based on the outcome of the last election would lead to point estimates ranging from 32.2% to 35.7%. Of the fifty-two additional estimates in Table 8 the lowest one is 28.4% and the highest one equals 41.1%. Slightly more than 90% of point estimates fall *within* the original 95%-confidence intervals. The evidence, therefore, suggests that misclassification of contestants is not a serious problem.

Social Interactions & Horizontal Differences in Candidate Quality There are, however, other threats to identification. First, the argument laid out in the introduction assumes that the share of agents who desert non-contenders does not depend on precincts' ideological composition (i.e. the position on the x-axis in Figure 1). This assumption is not innocuous. For instance, it rules out peer effects in voting, certain forms of sorting across precincts, or that the perception of candidate quality varies systematically with voters' political views. Fortunately, the assumption is testable.

To see this, note that all of the threats mentioned above imply a non-linear relationship between list and candidate votes for non-contenders. That is, if social interactions or differences in candidate perception were important, then one would expect desertion rates (and hence the slope of the line in Figure 1) to vary systematically with the position on the x-axis. Yet, estimating the relationship between list and candidate votes semi-parametrically, as shown in Figure 5, gives little reason to believe that the linearity assumption is problematic.

Moreover, recall that the results in Table 5 reveal only minor differences between estimates which constrain voters' assessment of candidate quality to be the same within a given district and those that allow for the perception of candidates to vary by municipality. Together these findings suggest that social interactions and horizontal differences in candidate quality cannot explain the results.

Endogenous Nomination of Candidates Another concern relates to the behavior of parties. Depending on the anticipated likelihood of winning the district, parties might nominate

a particularly "good" or "bad" candidate. Since the empirical strategy relies on within-candidate variation, this sort of behavior will only bias the point estimates if candidate quality *interacts* with the share of voters who behave sincerely—say, because voters might be reluctant to abandon very charismatic contestants. Although plausible, the data do not suggest that "good" candidates, as measured by $\chi_{k,t}$, are less likely to be deserted when they are "out of the race." If anything, additional results (available from the author upon request) show that the covariance between $\chi_{k,t}$ and a non-contender's λ_k is slightly negative.

Also note that the results cannot be driven by comparisons between direct candidates and those on the party list. While it is theoretically possible that some agents desert their favorite party's candidate because they would like someone else on the party list to enter parliament instead (see Section 3 or Appendix A for details on how seats are allocated), this behavior will not affect the estimates. First, none of the identifying variation comes from candidates who are in contention for victory, i.e. who have a realistic chance of entering the Bundestag and for whom this sort of comparison would be relevant. Second, the estimates above are based on within-candidate variation only, thereby *conditioning* on the characteristics of direct candidates, their competitors, as well as those on the party list.

Measurement Error Since list votes are hardly a perfect proxy for preferences over candidates, one may also worry about measurement error. The resulting attenuation bias would lead to estimates of λ that are smaller than one and, therefore, to incorrect inference about the prevalence of tactical behavior. However, measurement error should not only affect the estimated candidate-list vote gradient among non-contenders, but also that for contenders. Thus, looking at the *difference* in slopes for both sets of contestants, i.e. $\gamma - \lambda$, provides a way to address this concern. As the second row in Table 9 demonstrates, attenuation bias does not explain the results. In fact, the estimated extent of strategic voting remains almost unchanged.

Strategic List Votes As discussed in Section 3, a small number of voters might anticipate overhang mandates and thus cast tactical list votes. Although the vast majority of voters cannot reasonably assign a high probability to their preferred party winning an overhang mandate, it is useful to probe the robustness of the results with respect to this potential confound. The third row in Table 9 restricts attention to states in which overhang mandates had never occurred before 2005. Reassuringly, the resulting point estimates are very similar to their baseline values.

Now, consider the effects of agents casting tactical list votes for any other reason—say, because they (falsely) anticipated that FDP, Green Party, or The Left would have trouble clearing the 5%-threshold. There are two cases to distinguish: (i) Some voters might have

strategically chosen a party whose nominee was in contention for victory. These individuals do not contribute to identification of λ and will, therefore, not bias the point estimates. (ii) Others, however, might have cast a strategic list vote for a party whose direct candidate was "out of the race." These individuals do contribute to identification. But as long as they also deserted the respective non-contender they will be correctly classified as strategic. Only if they chose the dominated action of voting for a candidate who was not in contention for victory will they be counted as sincere. Of course, it is not clear whether voters who cast one tactical vote but waste the other should be deemed strategic *or* sincere. By classifying them as the latter the paper errs on the side of caution when it comes to estimating the extent of strategic voting. That is, if one believes that a non-trivial fraction of voters behave tactically under proportionality rule but make a "mistake" in the first-past-the-post system, then the estimates above provide a lower bound on the "true" extent of strategic behavior.[24]

It is important to emphasize that the identifying assumption throughout is not that list votes reveal voters' deep ideological convictions, but merely that they are a good proxy for individuals' preferences over candidates. For instance, agents may very well take expectations regarding post-election coalition formation into account and then vote for the party they would like to gain the marginal seat given these expectations. It only needs to be true that their choice of party is a good predictor for whichever candidate they would pick conditional on that candidate having a chance of winning. Given the evidence in Figure 4 this assumption does appear to be reasonable.

Additional Robustness Checks The remainder of Table 9 demonstrates that the results do not depend on the weighting scheme or on whether one also includes candidates of "micro parties."

6.4. *Correlates of Strategic Voting*

Taken together the results above show that a non-trivial fraction of agents behaves strategically. Yet, simple averages may conceal considerable heterogeneity across individuals. Since strategic voters are more likely to be pivotal and thus exert a disproportionate influence on the positioning of political candidates, it is also important to understand *who* votes tactically.

In order to infer whether λ varies with the characteristics of agents, the present paper relies on official statistics for the universe of German cities and villages, published by the

[24]To get a sense of the magnitude of the possible undercount consider the following back-of-the-envelope calculation. Suppose that one in ten list votes are strategic, and that agents who cast strategic list votes are not more likely to cast tactical candidate votes than those who submit sincere party votes. In such a case, Table 5 would understate the "true" extent of strategic voting by about 6 percentage points. Of course, this number would be substantially smaller if individuals who behave tactically with their list vote were also more likely to cast strategic candidate votes.

Federal Statistical Office and the statistical offices of the Länder (Statistische Ämter des Bundes und der Länder 2007, 2011).[25] After aggregating election results to the village level and focusing on the set of municipalities that are fully contained within an electoral district, it is straightforward to estimate specifications that allow for λ to increase or decrease in some village characteristic.

Table 10 displays the results. The first column demonstrates that aggregation to the municipality level does not materially affect the estimated share of sincere voters. The remaining four columns examine how λ changes with population density, income tax revenue per capita, as well as the gender and age composition of the electorate. For ease of interpretation covariates have been demeaned, so that the estimates in the second row refer to the share of sincere voters at the sample average.

Interestingly, urban voters are not more strategic than rural ones, nor is there a significant gender gap. The results do, however, indicate differences with respect to socio-economic status (as proxied by income tax revenue per capita) and age.

Since the income tax variable captures only revenues that accrue to the respective municipalities and given that the German tax system is highly non-linear, it is easiest to judge the magnitude of the coefficient by an example. Consider two villages: one's per capita income tax revenue is a standard deviation below the mean, while that of the other village is one standard deviation above the sample average.[26] The share of sincere voters is estimated to be almost 6 percentage points higher in the latter.

Disparities by age are much larger. Taken at face value the coefficient in column (5) suggests that the fraction of strategic agents is 24.4 percentage points lower among voters below the age of 30, i.e. those who could have participated in at most three federal elections. Of course, this estimate is based on limited variation, and therefore not very precise. But, together with the results in column (4), it suggests that sophistication and learning affect tactical behavior.

6.5. *Learning to Vote Strategically*

To further investigate the hypothesis of learning, this subsection uses the German Reunification as a natural experiment. Although the German Democratic Republic (GDR) held regular, formal elections to the *Volkskammer* (People's Chamber), they were effectively meaningless. East Germans could only choose from candidates on a single list controlled by the Socialist Unity Party (SED), and it was customary to cast one's ballot in public, simply accepting all nominated candidates. Unsurprisingly, official approval rates often exceeded

[25] Unfortunately, comparable data for polling precincts do not exist. Polling precincts are too small to produce reliable estimates from existing data sets.

[26] On average municipalities receive about 13% of all income tax revenues. Thus, the per capita sample mean is 260 EUR and the standard deviation equals 110 EUR.

99%. Free, democratic elections were only held on March 18, 1990—after months of peaceful political protest. The newly elected government then negotiated the end of the GDR.

In stark contrast, citizens of the Federal Republic of Germany have had the opportunity to participate in free elections since 1949; and from 1953 on under a two-ballot system almost identical to the current one. Thus, they had more than 40 years of democratic experience by the time the GDR joined the West.

The first parliamentary elections in unified Germany were held on December 2, 1990, and were subject to (essentially) the same rules that had previously been used in the West and that continue to be in place today.[27] If learning and familiarity with the electoral system do indeed matter, then one would expect large initial differences in the share of strategic voters, which should disappear over time.

This prediction corresponds exactly to the findings in Figure 6. For each election since 1990, the figure plots the estimated difference in the share of tactical voters between East and West Germany. Negative values indicate fewer strategic agents among residents of the former GDR.[28]

Just two months after reunification, East Germans were almost 16 percentage points less likely to vote strategically than their Western counterparts. By 2005, however, the gap had vanished. Although none of the point estimates is very precise, one can nevertheless reject the null hypothesis of a constant difference at the 1%-confidence level. Moreover, both the initial gap as well as the speed of convergence are in line with the "age effect" in Table 10. Thus, as in many laboratory experiments, sophistication and learning appear to be important determinants of tactical behavior.[29]

7. Counterfactual Seat Distributions

Although the results above indicate that a large fraction of voters are strategic, they are ultimately insufficient to judge whether lack of strategyproofness is of first order importance for electoral outcomes—especially since tactical voting might interact with whom parties select to run in a particular district. In order to assess the impact of strategic behavior by

[27]The most important exception was that the 5%-threshold applied separately to East and West Germany. Thus, in 1990 a party had to gain more than 5% of the list vote in only one of the two regions to enter the Bundestag.

[28]The specification on which the estimates are based is similar to equation (6), but allows for different slopes and cutoff values in East and West Germany. A qualitatively similar picture emerges if one were to restrict the cutoff to be the same in both regions.

[29]It is important to note that East Germans gained not only familiarity with the electoral system, but other economic factors changed as well. If these factors had an independent effect on the propensity to cast tactical ballots, then the estimates in Figure 6 need not capture the true impact of learning. Convergence in per capita incomes, however, is almost an order of magnitude too small to explain the results.

voters *and* parties, Figure 7 presents several counterfactuals for the 2009 federal election.[30]

The top left panel shows the actual distribution of seats in the Bundestag, whereas the panel on the right displays the distribution that would prevail if mandates were awarded based on a single vote counted under proportionality rule with a 5%-threshold, i.e. the list vote. Evidently, the actual Bundestag mirrors a parliament formed under proportional representation fairly closely: all five major parties are represented, with more than 60% of seats accruing to the CDU and the SPD. In the current equilibrium, distortions introduced through strategic candidate votes are very small.

The two remaining panels consider the case of a single vote counted under plurality rule in the existing 299 districts—akin to elections in many Anglo-Saxon countries. The counterfactual on the bottom left assumes the current extent of tactical voting as well as the current, strategically nominationed set of candidates. By contrast, in the panel on the bottom right voters do not misrepresent their preferences and candidates are perfect party representatives. Note, the German context allows for these counterfactuals to be constructed *directly* from the data, i.e. from actual candidate (left panel) and list votes (right panel).[31]

In line with common intuition, relative to proportional representation a "winner-take-all" system would result in dramatic losses for small parties. However, as comparing the panels on the right shows, these losses are due to the way different electoral rules map vote shares into mandates and not to tactical behavior.

The impact of strategic behavior can be gleaned from comparing the two counterfactuals on the bottom. Given its estimated extent, tactical voting has only modest effects on the overall allocation of seats. On average the five major parties' seat shares change by only 2.4 percentage points, and not a single party experiences a change of more than 6 percentage points. As shown in Appendix Figure A.2, these differences are considerably smaller in 2005. Despite a higher estimated extent of tactical voting (cf. Table 6), no party's share of seats would change by more than 1.3 percentage points if all strategic behavior was shut down. And Figure A.3 demonstrates that these conclusions do not depend on the assumption that candidates are perfect party representatives. If anything the effect of strategic voting would be even smaller if parties were allowed to field the current set of candidates.[32] Although the impact of stragetic voting depends on the distribution of preferences, at first glance it might

[30]Counterfactuals for the 2005 election are qualitatively very similar, and appear in Appendix Table A.1 and Figure A.2.

[31]An earlier version of this paper estimates a fully structural model of voting decisions (see Spenkuch 2013). Since conclusions from counterfactuals based on the results of the structural model are qualitatively identical to those that can be derived directly from the data, the present manuscript conserves space by presenting only the latter.

[32]The counterfactuals in Appendix Figure A.3 are based on list vote shares adjusted for the municipality specifc candidate-year fixed effects estimated from equation (6).

appear that lack of strategyproofness has only a small effect on electoral outcomes.

Yet, looking only at seat totals misses an important point. As the evidence in Table 11 indicates, compared to the current equilibrium, about one in ten districts do change hands as a result of strategic behavior. Thus, even moderate degrees of tactical voting may have a non-negligible impact on a given race—as predicted by theory. But as the number of heterogenous districts becomes large, these "distortions" tend to average out. In fact, the effect of tactical behavior on aggregate seat totals will always be (weakly) lower than that on individual races.

8. Concluding Remarks

Whether individuals vote strategically is one of the most important questions at the intersection of economics and political science. Although tactical voting has interested social scientists for decades, it has proven very difficult to determine its extent. The fundamental problem is that voters' preferences are generally unobserved, which makes it nearly impossible to compare them to actual votes without imposing strong assumptions.

The present paper resolves this problem by exploiting the structure of parliamentary elections in Germany. The German system allows for preferences to be held fixed, while contrasting the behavior of the same individuals under different electoral regimes. The evidence indicates that between 30% and 40% of voters behave as predicted by rational choice theory.

Although strategic voting has a non-trivial impact on individual races, its effect on the overall distribution of seats is considerably more modest. No party's seat total would change by more than a few percentage points if all voters behaved sincerely. Depending on the application it may be important to distinguish between the "micro" and "macro" effects of tactical behavior.

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Figure 1: Theoretical Predictions under Sincere and Strategic Voting

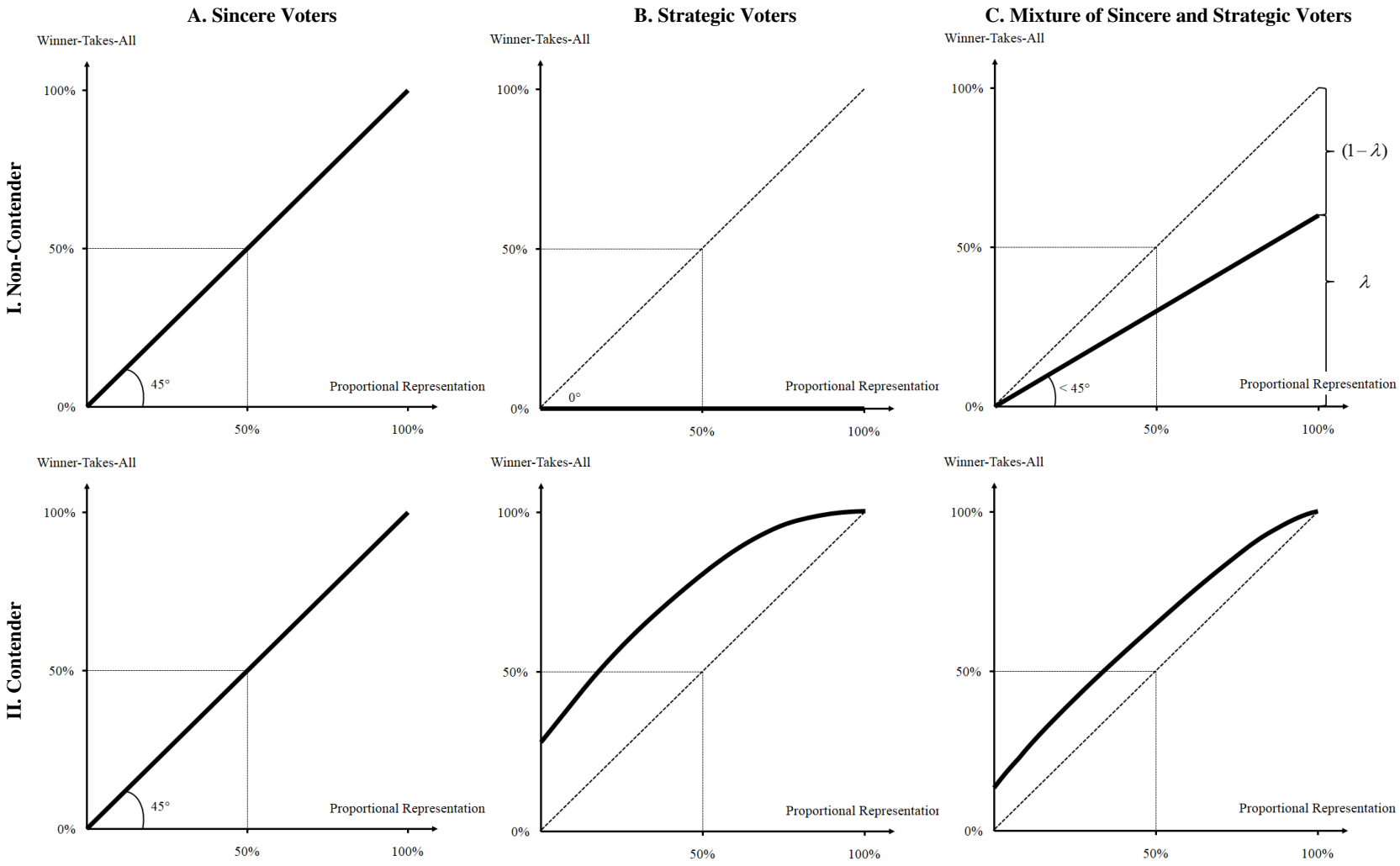
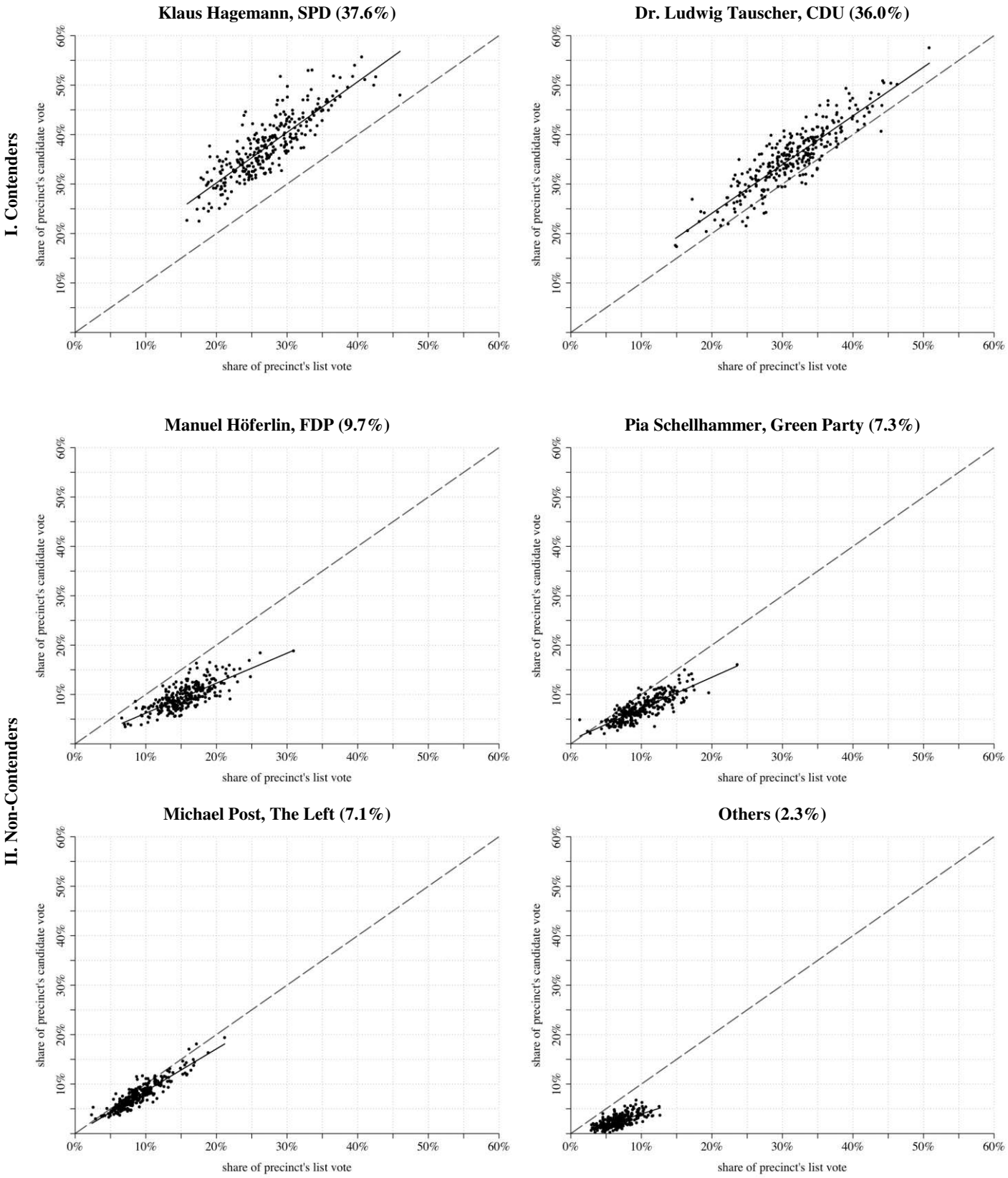
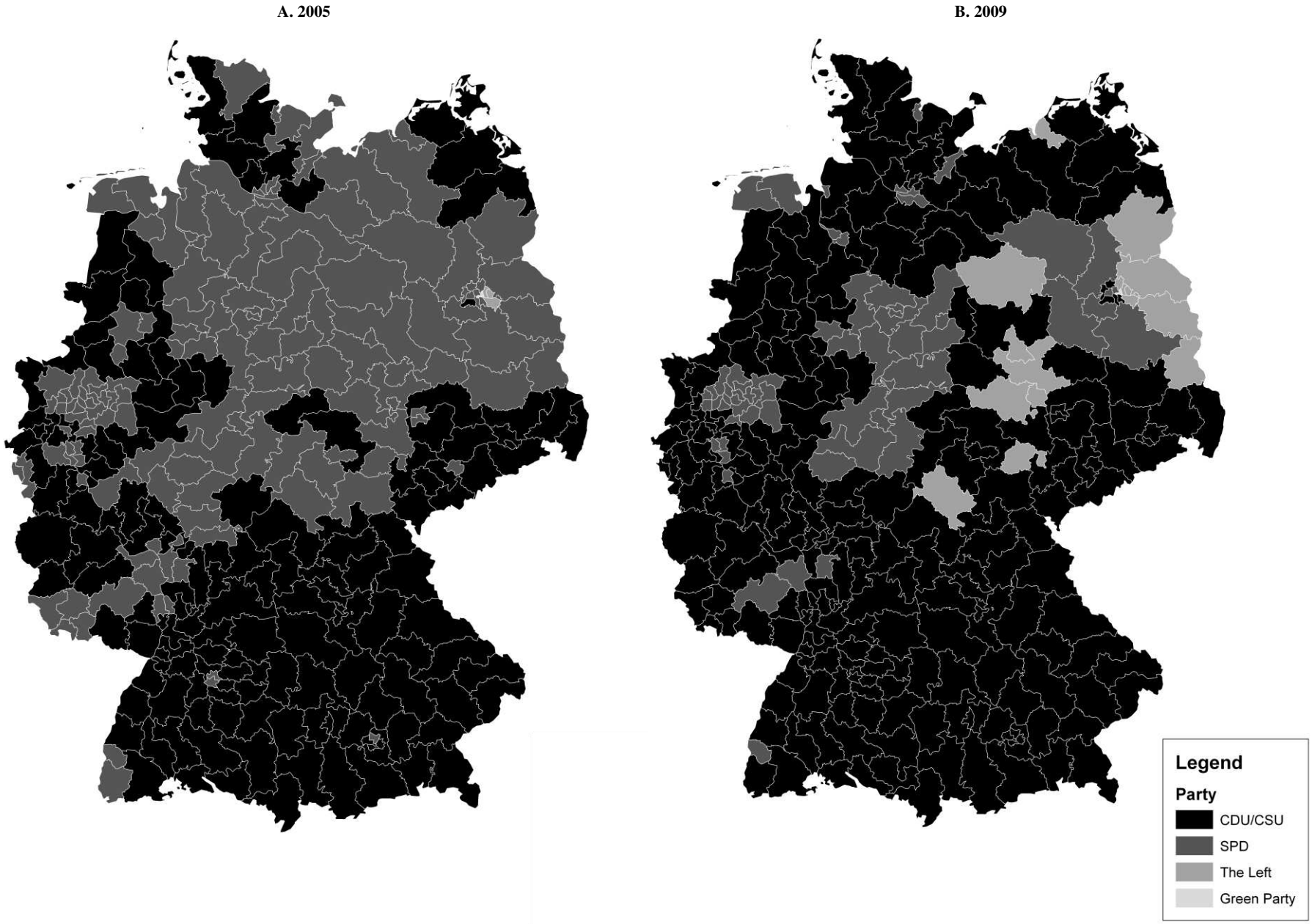


Figure 2: Empirical Example, 2009 Federal Election in Electoral District 207



Notes: Figure depicts the relationship between list votes and candidate votes for contenders (upper two panels) as well as non-contenders (lower four panels) in District 207 during the 2009 federal election. Each dot corresponds to one electoral precinct.

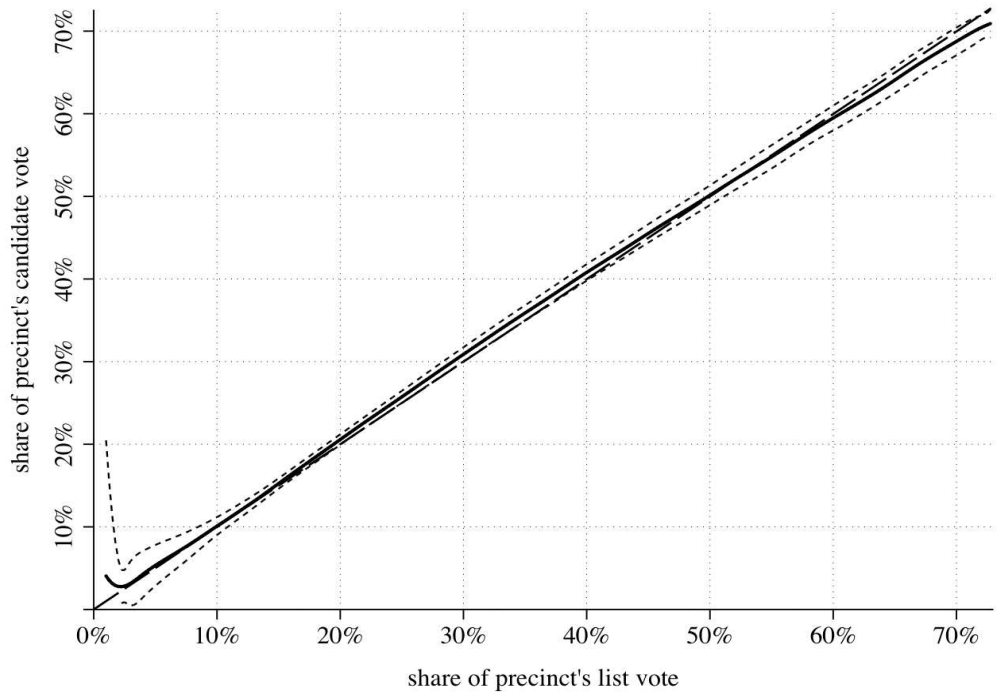
Figure 3: Distribution of Direct Mandates in the 2005 and 2009 Federal Elections



Notes: Figure depicts majority of the candidate vote by electoral district and candidates' party affiliation in the 2005 (left) and 2009 (right) federal elections. In the 2005 (2009) election, candidates running for the CDU/CSU won the plurality of votes in 150 (218) out of 299 electoral districts. SPD candidates gained 145 (64) direct mandates. Candidates of the The Left won 3 (16) districts, and the Green Party achieved 1 (1) direct mandate. No FDP contestant won a district race.

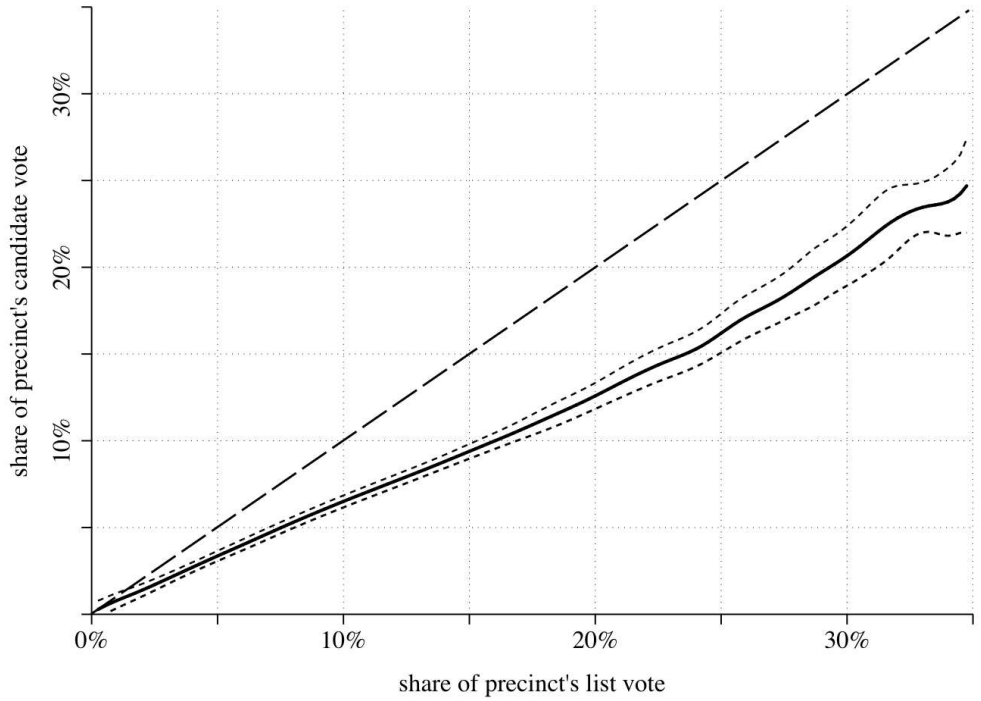
Sources: Based on Bundeswahlleiter (2005a, 2005b, 2008, 2009a).

Figure 4: Relationship between List and Candidate Votes for Contenders



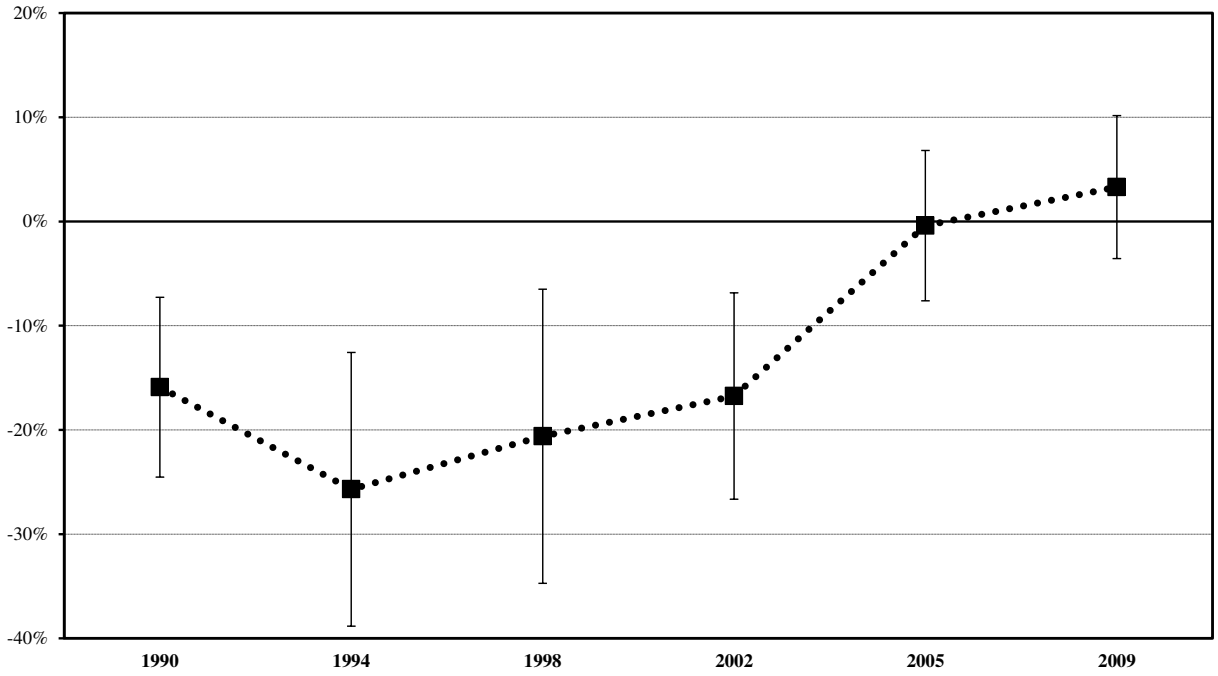
Notes: Figure shows a semi-parametric estimate of the relationship between list and candidate votes for district winners and runner-ups, i.e. $f(\cdot)$ in equation (4), as well as the associated asymptotic 95%-confidence interval. $f(\cdot)$ is approximated by cubic B-splines with knots at every 3 percentage points. Standard errors account for clustering at the state level and have been caclulated using the block bootstrap with 1,000 iterations.

Figure 5: Relationship between List and Candidate Votes for Non-Contenders



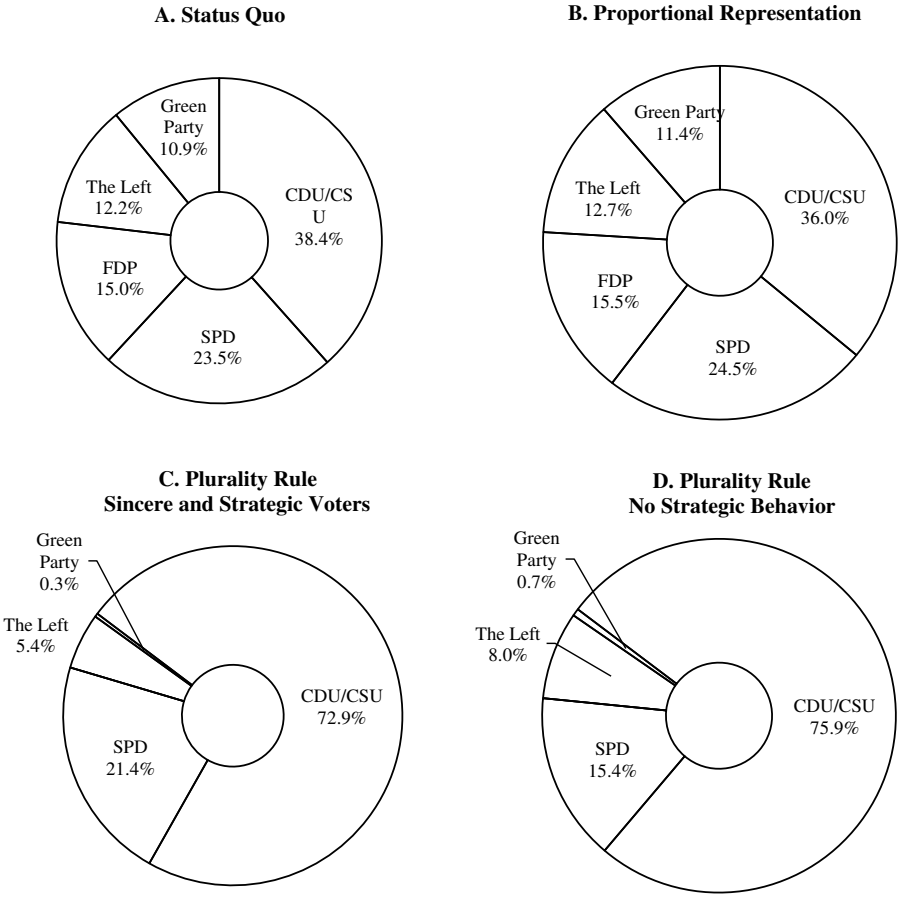
Notes: Figure shows a semi-parametric estimate of the relationship between list and candidate votes for non-contenders, i.e. $f(\cdot)$ in equation (4), as well as the associated asymptotic 95%-confidence interval. $f(\cdot)$ is approximated by cubic B-splines with knots at every 1.5 percentage points. Standard errors account for clustering at the state level and have been caclulated using the block bootstrap with 1,000 iterations.

Figure 6: Difference in the Share of Strategic Voters between East and West Germany, 1990–2009



Notes: Figure shows the percentage point difference in the share of strategic voters between East and West Germany for each federal election from 1990 to 2009 as well as the associated 95%-confidence intervals. Negative values indicate fewer strategic voters among residents of the former GDR. The null hypothesis of a constant difference across all years can be rejected at the 1%-confidence level, and that of an equal difference in 1990 and 2009 is rejected at the 1%-level as well.

Figure 7: Counterfactual Seat Distributions in the 17th Bundestag



Notes: Figure depicts counterfactual seat distributions in the Bundestag following the 2009 federal election. See the main text for a description of the assumptions underlying each panel.

Table 1: Distribution of List and Candidate Votes in the 2009 Federal Election

Party	Number of Direct Mandates	Share of Candidate Vote	Share of List Vote	Candidate Vote as Fraction of Party's List Vote						
				CDU/CSU	SPD	The Left	Green Party	FDP	Others	Invalid
CDU/CSU	218	38.7%	33.3%	**.876**	.042	.007	.017	.048	.005	.006
SPD	64	27.5%	22.7%	.045	**.858**	.024	.052	.011	.004	.006
The Left	16	10.9%	11.7%	.031	.128	**.757**	.048	.017	.014	.005
Green Party	1	9.0%	10.6%	.061	.333	.036	**.536**	.021	.008	.004
FDP	0	9.3%	14.4%	.458	.048	.011	.021	**.448**	.009	.005
Others	0	2.9%	5.9%	.133	.130	.114	.125	.090	**.378**	.030
Invalid	--	1.7%	1.4%	.117	.079	.025	.013	.021	.013	**.732**

Notes: Entries denote each party's number of direct mandates, share of the list and candidate vote, as well as the frequency of different list and candidate vote combinations (calculated as fraction of a party's list vote) in the 2009 federal election. Due to rounding entries may not add up to unity.
Source: Author's calculations based on Bundeswahlleiter (2009a, 2010).

Table 2A: Characteristics of Direct Candidates

Variable	Full Sample	Party Affiliation					
		CDU/CSU	SPD	FDP	The Left	Green Party	Others
Age	47.16	49.14	48.87	44.96	49.29	44.01	46.94
	(11.97)	(9.72)	(9.83)	(11.29)	(10.48)	(10.97)	(14.45)
Female	.226	.191	.353	.169	.259	.344	.139
	(.418)	(.393)	(.478)	(.375)	(.438)	(.475)	(.346)
Doctorate	.109	.204	.134	.161	.090	.105	.041
	(.312)	(.403)	(.341)	(.367)	(.287)	(.306)	(.199)
Currently Member of Parliament	.231	.652	.602	.161	.083	.148	.002
	(.422)	(.477)	(.490)	(.367)	(.277)	(.356)	(.039)
Holds Direct Mandate	.111	.376	.403	.000	.009	.003	.001
	(.315)	(.485)	(.491)	(.000)	(.092)	(.058)	(.028)
Also on Party List	.626	.759	.950	.888	.434	.546	.414
	(.484)	(.428)	(.218)	(.316)	(.496)	(.498)	(.493)
Position on Party List | Also List Candidate	12.89	13.26	17.36	17.47	9.40	8.89	7.32
	(12.86)	(12.79)	(15.46)	(15.32)	(8.19)	(6.94)	(7.02)
	4,257	598	598	598	587	593	1,283

Notes: Entries are means and standard deviations of characteristics of direct candidates running in the 2005 or 2009 federal elections, by party affiliation. See the Data Appendix for the precise definition and source of each variable.

Table 2B: Summary Statistics for Electoral Precincts

		West Germany		East Germany	
Variable	Full Sample	2005	2009	2005	2009
Number of Eligible Voters	820.7	821.5	834.2	782.9	802.5
	(406.1)	(385.4)	(387.6)	(460.3)	(487.7)
Turnout	.747	.789	.727	.751	.658
	(.087)	(.071)	(.083)	(.069)	(.084)
Share of Candidate Vote (in %):					
CDU/CSU	41.07	44.81	41.94	29.65	32.94
	(13.02)	(13.33)	(11.49)	(9.93)	(10.32)
SPD	32.23	38.73	28.80	31.35	20.03
	(12.61)	(12.66)	(10.71)	(8.28)	(7.54)
FDP	7.04	4.59	9.66	5.16	8.17
	(3.93)	(2.25)	(3.74)	(2.85)	(3.73)
The Left	9.66	3.95	7.35	24.86	28.61
	(9.67)	(3.06)	(4.01)	(7.37)	(8.46)
Green Party	6.87	5.46	9.32	3.76	5.53
	(5.29)	(3.78)	(5.23)	(5.80)	(6.08)
Others	3.08	2.38	2.88	5.22	4.72
	(2.88)	(2.75)	(2.59)	(3.10)	(2.70)
Share of List Vote (in %):					
CDU/CSU	35.47	38.67	35.59	26.21	30.65
	(11.60)	(12.48)	(10.25)	(8.59)	(8.92)
SPD	27.98	34.22	23.62	29.96	17.95
	(10.91)	(10.84)	(8.63)	(7.16)	(5.94)
FDP	12.01	10.10	15.18	8.00	10.57
	(4.83)	(3.56)	(4.61)	(3.25)	(3.76)
The Left	10.43	4.83	8.40	25.05	28.27
	(9.23)	(3.09)	(4.26)	(6.26)	(7.56)
Green Party	8.83	8.38	10.93	4.78	5.90
	(5.38)	(4.87)	(5.25)	(4.13)	(4.93)
Others	5.23	3.71	6.23	6.01	6.66
	(2.85)	(2.03)	(2.76)	(3.03)	(3.03)
Absentee Precinct	.148	.155	.166	.090	.098
	(.355)	(.362)	(.372)	(.286)	(.297)
	177,425	71,614	72,056	17,110	16,645

Notes: Entries are means and standard deviations for all precinct level variables used in the analysis, differentiating between East and West Germany as well as election year. See the Data Appendix for a precise definition of each variable.

Table 3: Testing the Null Hypothesis of Sincere Voting

	Share of Candidate Vote				
Independent Variable	(1)	(2)	(3)	(4)	(5)
Share of List Vote	1.205	1.018	.936	.937	.891
	(.022)	(.012)	(.007)	(.008)	(.014)
Constant	-3.440				
	(.430)				
Fixed Effects:					
Party	No	Yes	No	No	No
Candidate	No	No	Yes	No	No
Candidate × Year	No	No	No	Yes	No
Candidate × Municipality × Year	No	No	No	No	Yes
R-Squared	.936	.961	.979	.980	.987
Number of Observations	882,061	882,061	882,061	882,061	882,061

Notes: Entries are coefficients and standard errors from estimating equation (3) by ordinary least squares. Heteroskedasticity robust standard errors are clustered by state and reported in parentheses. See the Data Appendix for the precise definition and source of each variable.

Table 4: Ranking of Candidates in the 2005 & 2009 Federal Elections

Rank Based on	Rank Based on List Vote					
Candidate Vote	1	2	3	4	5	6
1	**557**	38	3	0	0	0
2	39	**502**	54	3	0	0
3	2	44	**369**	139	39	5
4	0	14	131	**306**	138	9
5	0	0	39	139	**332**	87
6	0	0	2	11	88	**474**
Total	598	598	598	598	597	575
First or Runner-Up	99.7%	90.3%	9.5%	0.5%	0.0%	0.0%

Notes: Entries denote the number of candidates for each combination of own rank based on received candidate votes (left column) and the within district ranking of the associated party based on the list vote in the same year (top row). For instance, out of the 598 candidates whose party received the most list votes within a particular district, 557 won the direct mandate for that district, 39 candidates finished in second place, and 2 ended up third. The rank order correlation within districts is .93.

Table 5: Estimating the Extent of Strategic Voting

A. Candidates Trailing Far Behind

	Share of Candidate Vote				
Independent Variable	(1)	(2)	(3)	(4)	(5)
Share of List Vote	.621	.682	.670	.632	.613
	(.027)	(.013)	(.010)	(.014)	(.016)
Constant	.676				
	(.193)				
Fixed Effects:					
Party	No	Yes	No	No	No
Candidate	No	No	Yes	No	No
Candidate × Year	No	No	No	Yes	No
Candidate × Municipality × Year	No	No	No	No	Yes
R-Squared	.622	.717	.816	.832	.885
Number of Observations	463,544	463,544	463,544	463,544	463,544

B. All Candidates

	Share of Candidate Vote				
Independent Variable	(1)	(2)	(3)	(4)	(5)
Share of List Vote	.819	.765	.696	.657	.656
× Non-Contender	(.063)	(.022)	(.021)	(.019)	(.026)
Share of List Vote	1.118	1.060	.982	1.004	.977
× Contender	(.016)	(.010)	(.010)	(.012)	(.021)
Non-Contender	-.596	3.664	-3.887		
	(.441)	(.433)	(.614)		
Contender	.649	6.477	-.742		
	(.767)	(.717)	(.140)		
Structural Break	.009	.021	.065	.064	.023
Fixed Effects:					
Party	No	Yes	No	No	No
Candidate	No	No	Yes	No	No
Candidate × Year	No	No	No	Yes	No
Candidate × Municipality × Year	No	No	No	No	Yes
R-Squared	.951	.965	.980	.982	.989
Number of Observations	882,061	882,061	882,061	882,061	882,061

Notes: Entries are coefficients and standard errors from estimating equation (5) (upper panel) and equation (6) (lower panel) by ordinary least squares. The upper panel restricts the sampel to candidates who finished more than 10 percentage points behind second place, whereas the lower panel includes all candidates. Heteroskedasticity robust standard errors are clustered by state and reported in parentheses. See the Data Appendix for the precise definition and source of each variable.

Table 6: Comparative Statics

	Share of Strategic Voters	
Fixed Effects:		Candidate ×
Restriction	Candidate × Year	Municipality × Year
Baseline	.343	.344
	(.019)	(.026)
By Availability of Close Substitute:		
Allied Party's Candidate in the Race	.366	.379
	(.015)	(.018)
Only Rival Parties' Candidates in the Race	.138	.115
	(.015)	(.012)
By Difference Between Winner and Runner-Up:		
< 1%	.382	.394
	(.043)	(.034)
1% and 5%	.356	.378
	(.026)	(.028)
> 5%	.312	.338
	(.026)	(.026)
By Year:		
2005	.452	.512
	(.027)	(.016)
2009	.236	.274
	(.025)	(.021)

Notes: Entries are coefficients and standard errors on $1-\lambda$ estimated from equation (6), using different subsamples of the data. The respective restriction is indicated on the left of each row. See the Data Appendix for the precise definition and source of each variable.

Table 7: Candidate-List-Vote Gradient among Second Ranked Candidates

	Slope	
Fixed Effects:		Candidate ×
Distance to First Ranked Candidate	Candidate × Year	Municipality × Year
Based on Preferences:		
< 2% behind First Ranked Candidate	1.025	1.008
	(.013)	(.017)
2% to 5% behind First Ranked Candidate	1.019	.988
	(.012)	(.017)
5% to 10% behind First Ranked Candidate	1.058	1.032
	(.015)	(.019)
10% to 15% behind First Ranked Candidate	1.044	.996
	(.021)	(.035)
> 15% behind First Ranked Candidate	1.033	.992
	(.023)	(.044)
Based on Ex Post Outcome of Races:		
< 2% behind First Ranked Candidate	1.025	1.008
	(.020)	(.033)
2% to 5% behind First Ranked Candidate	1.042	1.024
	(.014)	(.018)
5% to 10% behind First Ranked Candidate	1.049	1.019
	(.014)	(.018)
10% to 15% behind First Ranked Candidate	1.061	1.024
	(.024)	(.029)
> 15% behind First Ranked Candidate	1.022	.975
	(.016)	(.035)

Notes: Entries denote the candidate-list-vote gradient for second ranked candidates, by distance to the first ranked one. The respective cutoffs are shown in the column on the left. Heteroskedasticity robust standard errors are clustered by state and reported in parentheses.

Table 8: Sensitivity Analysis Using Alternative Classifications of Contenders

	Share of Strategic Voters	
Fixed Effects:		Candidate ×
Classification of Contenders	Candidate × Year	Municipality × Year
Baseline (Preference Based, Original Cutoff)	.343	.344
	(.019)	(.026)
Ex Post Outcome of Races (Original Cutoff)	.345	.349
	(.018)	(.026)
Preference Based Using Different Cutoffs:		
< 1% behind Second Ranked Candidate	.295	.332
	(.029)	(.028)
< 2% behind Second Ranked Candidate	.307	.339
	(.027)	(.027)
< 5% behind Second Ranked Candidate	.331	.359
	(.021)	(.020)
< 8% behind Second Ranked Candidate	.352	.377
	(.017)	(.017)
< 10% behind Second Ranked Candidate	.366	.391
	(.015)	(.014)
< 12% behind Second Ranked Candidate	.385	.411
	(.012)	(.009)
Ex Post Outcome of Races Using Different Cutoffs:		
< 1% behind Second Ranked Candidate	.310	.342
	(.027)	(.028)
< 2% behind Second Ranked Candidate	.317	.348
	(.026)	(.026)
< 5% behind Second Ranked Candidate	.337	.365
	(.020)	(.021)
< 8% behind Second Ranked Candidate	.350	.374
	(.018)	(.020)
< 10% behind Second Ranked Candidate	.368	.387
	(.014)	(.016)
< 12% behind Second Ranked Candidate	.382	.403
	(.011)	(.011)
Ranked First or Second Based on Preferences	.284	.324
	(.030)	(.030)
Ranked First, Second, or Third Based on Preferences	.299	.335
	(.023)	(.017)
Ranked First or Second Based on Ex Post Outcome	.305	.337
	(.029)	(.029)
Ranked First, Second, or Third Based on Ex Post Outcome	.371	.400
	(.013)	(.014)
Finished First or Second in Last Federal Election	.287	.322
	(.032)	(.034)
Finished First, Second, or Third in Last Federal Election	.319	.357
	(.015)	(.011)
Finish in Last Federal Election (Original Cutoff)	.316	.330
	(.026)	(.031)
Finish in Last Federal Election Using Different Cutoffs:		
< 1% behind Second Ranked Candidate	.291	.326
	(.031)	(.032)
< 2% behind Second Ranked Candidate	.296	.330
	(.030)	(.032)
< 5% behind Second Ranked Candidate	.313	.344
	(.027)	(.029)
< 8% behind Second Ranked Candidate	.322	.352
	(.024)	(.027)
< 10% behind Second Ranked Candidate	.329	.358
	(.022)	(.023)
< 12% behind Second Ranked Candidate	.337	.366
	(.019)	(.019)

Notes: Entries are coefficients and standard errors on 1-λ using alternative classifications of "contender." The respective definition is shown in the column on the left. Heteroskedasticity robust standard errors are clustered by state and reported in parentheses.

Table 9: Additional Sensitivity and Robustness Checks

	Share of Strategic Voters	
Fixed Effects:		Candidate ×
Restriction	Candidate × Year	Municipality × Year
Baseline	.343	.344
	(.019)	(.026)
Difference Estimator	.347	.322
	(.027)	(.038)
In States without Overhang Mandates	.376	.391
	(.029)	(.031)
Weighted by Number of Party Supporters	.322	.328
	(.029)	(.037)
Including "Other" Party Candidates	.341	.355
	(.020)	(.025)

Notes: Entries are coefficients and standard errors on the share of strategic voters, i.e. 1-λ, using different subsamples of the data and weighting schemes. The respective restriction is indicated on the left of each row. See the Data Appendix for the precise definition and source of each variable.

Table 10: Correlates of Strategic Voting

	Share of Candidate Vote				
Independent Variable	(1)	(2)	(3)	(4)	(5)
Share of List Vote	1.008	1.008	1.008	1.008	1.008
× Contender	(.009)	(.009)	(.009)	(.009)	(.009)
Share of List Vote	.666	.644	.664	.605	.679
× Non-Contender	(.031)	(.029)	(.030)	(.033)	(.022)
Share of List Vote		-.005			
× Non-Contender × Population Density		(.007)			
Share of List Vote			.019		
× Non-Contender × Fraction of Voters Female			(.023)		
Share of List Vote				-.271	
× Non-Contender × Income Tax Revenue per Capita				(.078)	
Share of List Vote					.244
× Non-Contender × Fraction of Voters under Age 30					(.074)
Candidate × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
R-Squared	.984	.984	.984	.984	.984
Number of Observations	120,700	120,700	120,700	120,700	120,700

Notes: Entries are coefficients and standard errors from estimating specifications analogous to equation (6) by ordinary least squares, with a structural break at κ=.064. Heteroskedasticity robust standard errors are clustered by state and reported in parentheses. For ease of interpretation, covariates interacted with Share of List Vote × Non-Contender have been demeaned. In addition to the variables shown in the table, indicator variables for missing values on each covariate are also included in the regressions. See the Data Appendix for the precise definition and source of each variable.

Table 11: District Level Impact of Strategic Behavior, 2009 Federal Election

District Winner with No Strategic Behavior	District Winner in Current Equilibrium				
	CDU/CSU	SPD	FDP	The Left	Green Party
CDU/CSU	**70.90%**	5.02%	0.00%	0.00%	0.00%
SPD	0.33%	**15.05%**	0.00%	0.00%	0.33%
FDP	0.00%	0.00%	**0.00%**	0.00%	0.00%
The Left	1.67%	1.00%	0.00%	**5.35%**	0.00%
Green Party	0.00%	0.33%	0.00%	0.00%	**0.00%**

Notes: Entries compare the distribution of district winners in a first-past-the-post system with only sincere voters and no strategic nomination of candidates (left column) to the one that would obtain with a mixture of types and tactical nomination (top row). Summing across columns gives the percentage of districts that would acrue to a particular party if all voters behaved sincerely and if parties could not strategically nominate candidates, whereas summing across rows gives a party's share of districts in the current equilibrium. Consequently, adding the entries on the diagonal shows that about 91% of districts would accrue to the same party.

APPENDIX MATERIAL
[NOT FOR PUBLICATION]

Appendix A: Calculating a Party's Number of Seats

Following Spenkuch (2013), this appendix explains the algorithm that is currently used to calculate a party's number of seats in the Bundestag. Let $d_{p,s}$ denote the number of direct mandates accruing to party p in state s. $v_{p,s}$ is the number of list votes that p received in s, with the equivalent number on the national level given by $\overline{v}_p = \sum_s v_{p,s}$. With this notation in hand, party p's seat total is calculated in three steps:

Step 1: Proportional Allocation of List Mandates to Parties. Absent overhang mandates, there are 598 seats in the Bundestag. These are allocated by proportionality rule to the set of parties clearing the 5%-threshold or winning at least three direct mandates. That is, the number of list mandates of party p equals

$$\bar{l}_p \cong \begin{cases} 598 \frac{\overline{v}_p}{\sum_{p' \in \widetilde{P}} \overline{v}_{p'}} & \text{if } p \in \widetilde{P} \\ 0 & \text{otherwise} \end{cases},$$

where $\widetilde{P} = \left\{ p | \frac{\overline{v}_p}{\sum_{p'} \overline{v}_{p'}} \geq .05 \vee \sum_s d_{p,s} \geq 3 \right\}$ and $\cong$ represents equality after rounding according to the Sainte-Laguë method, which ensures that $\sum_p \bar{l}_p = 598$.[33]

Step 2: Proportional Allocation of Mandates to State Lists. German electoral law requires parties to compete with different lists in each state. Therefore, list mandates need to be allocated to the respective state lists. In practice, the number of mandates awarded to a party's state list is proportional to the list's contribution to the party's vote total. More precisely, for all s and all p,

$$l_{p,s} \cong \begin{cases} \bar{l}_p \frac{v_{p,s}}{\overline{v}_p} & \text{if } p \in \widetilde{P} \\ 0 & \text{otherwise} \end{cases},$$

where $\cong$ is defined as above.

Step 3: Determination of the Actual Number of Seats. However, the *actual* number of seats that party p receives in state s is given by

$$n_{p,s} = \max \{ d_{p,s}, l_{p,s} \}.$$

If $d_{p,s} < l_{p,s}$ then, in addition to the district winners, the first $l_{p,s} - d_{p,s}$ candidates on p's list in s are elected to the Bundestag as well. Otherwise, only holders of direct mandates receive a seat.

Note that only if $d_{p,s} \leq l_{p,s}$ for all s, will party p's seat total, $\overline{n}_p = \sum_s n_{p,s}$, be equal to the number of seats it would be assigned under proportional representation, i.e. $\bar{l}_p$.

[33] In 2005 the method of Hare-Niemeyer was used instead.

Appendix B: Marginal Seats, and Sincerity under Plurality Rule

To clarify in which sense agents can be expected to vote for the party they wish to gain the "marginal seat" in parliament this appendix provides a simple model of voting under proportionality rule in large elections.

Individual i receives utility $u(v)$ from realized vote totals $v = (v_p)_{p \in P}$.[34] Thus, conditional on v, i would choose party p only if $u(v_p + 1, v_{-p}) \geq u(v_{p'} + 1, v_{-p'})$ for all $p' \in P$. Rewriting $u(v)$ as $\widetilde{u}(s)$ with $s_p \equiv \frac{v_p}{\sum_{p' \in P} v_{p'}}$, it is easy to show that in large elections the previous condition is closely approximated by $\frac{\partial \widetilde{u}(s)}{\partial s_p} \geq \frac{\partial \widetilde{u}(s)}{\partial s_{p'}}$. Let $\varphi(s)$ denote i's belief about the probability of event s being realized (not counting her own vote). With this notation in hand, it will be the case that i chooses to vote for p whenever

$$\sum_s \varphi(s) \frac{\partial \widetilde{u}(s)}{\partial s_p} \geq \sum_s \varphi(s) \frac{\partial \widetilde{u}(s)}{\partial s_{p'}} \tag{7}$$

for all p'.

Note, abstracting from rounding proportionality rule implies that s_p does not only equal party p's own vote share, but also its seat total in parliament. Thus, $\frac{\partial \widetilde{u}(s)}{\partial s_p}$ denotes the utility gain to i from p winning the "marginal seat" conditional on the distribution of seats being s; and equation (7) shows that agents vote for the party that gives them the highest expect marginal utility from a small increase in its seat share.

Appendix C: Proofs

Proof of Proposition 1: To demonstrate existence of voting equilibria this proof adapts the fixed point argument in Myerson (1998, 2000).

First, let ex ante beliefs about pivot probabilities be accurate and express expected utility as a function of voters' strategies:

$$\widehat{u}_\imath(\delta, \sigma) = \sum_{k \in K} \left[\delta(k|\imath) \sum_{\tau \in Z(K)} \left(\prod_{k' \in K} \psi(\tau(k') | \mu(k'|\sigma)) \right) p(k, \tau|\imath) \right],$$

with payoffs given by $p(k, \tau|u, s) = u_k$ and

$$p(k, \tau|u, t) = \begin{cases} \frac{1}{2}(u_k - u_{k'}) & \text{if } \exists k' \in K \text{ s.t. } \tau(k') = \tau(k) \wedge \tau(k) \geq \tau(k'') \, \forall k'' \in K \setminus \{k'\} \\ \frac{1}{2}(u_k - u_{k'}) & \text{if } \exists k' \in K \text{ s.t. } \tau(k') = \tau(k) + 1 \wedge \tau(k) \geq \tau(k'') \, \forall k'' \in K \setminus \{k'\} \\ 0 & \text{otherwise} \end{cases}. \tag{8}$$

Here $\widehat{u}_\imath$ denotes the expected utility of a type $\imath \in \mathcal{I}$ voter who pursues strategy $\delta \in \Delta(K)$

[34] In the context of Germany it is useful to think of $u(v)$ as *conditional* on the expected outcome in the plurality rule part of the system, i.e. the district level races.

when everybody else plays $\sigma \in \Delta(K)^{\mathcal{I}}$, $\mu(k|\sigma) \equiv n\sum_{u\in U}[\lambda\sigma(k|u,s)+(1-\lambda)\sigma(k|u,t)]f(u)$, and $Z(K)$ is the set of all possible action profiles, i.e. the number of other players who choose actions $(\tau(k))_{k\in K}$.[35] Next, define the best response correspondence $B:\Delta(K)^{\mathcal{I}} \rightrightarrows \Delta(K)^{\mathcal{I}}$ such that, for all σ, $B=(B_\imath(\sigma))_{\imath\in\mathcal{I}}$, where $B_\imath(\sigma)\equiv\{\delta|\widehat{u}_\imath(\delta,\sigma)\geq\widehat{u}_\imath(\delta',\sigma)\,\forall\delta'\in\Delta(K)\}$. With these definitions in hand it suffices to show that there exists a set of mixed strategies for which $\sigma\in B(\sigma)$. The remainder of the proof verifies that the conditions for Kakutani's Fixed Point Theorem are satisfied.

By definition of $\Delta(K)$ as k-dimensional simplex, $\Delta(K)^{\mathcal{I}}$ is a non-empty, compact, and convex subset of a finite dimensional Euclidean space.

As $\widehat{u}=(\widehat{u}_\imath)_{\imath\in\mathcal{I}}$ is continuous, it follows from the definition of B, compactness of $\Delta(K)^{\mathcal{I}}$, and the Weierstrass Extreme Value Theorem that $B(\sigma)$ is non-empty.

Moreover, $B(\sigma)$ is convex-valued. To see this note that if $\delta',\delta''\in B_\imath(\sigma)$, then, for all $\alpha\in[0,1]$, $\alpha\widehat{u}_\imath(\delta',\sigma)+(1-\alpha)\widehat{u}_\imath(\delta'',\sigma)\geq\widehat{u}_\imath(\delta''',\sigma)\,\forall\delta'''\in\Delta(K)$. Also, $\alpha\widehat{u}_\imath(\delta',\sigma)+(1-\alpha)\widehat{u}_\imath(\delta'',\sigma)=\widehat{u}_\imath(\alpha\delta'+(1-\alpha)\delta'',\sigma)$ because $\widehat{u}_\imath$ is linear in δ. Together with the previous statement this implies $\alpha\delta'+(1-\alpha)\delta''\in B_\imath(\sigma)$, as required.

By way of contradiction suppose that $B(\sigma)$ does not have a closed graph. Then there exists a sequence $(\sigma_n,\delta_n)\to(\sigma,\delta)$ such that $\delta_n\in B(\sigma_n)$ but $\delta\notin B(\sigma)$. Hence, $\exists\delta'\in\Delta(K)$ and some $\epsilon>0$ for which $u_\imath(\delta',\sigma)>u_\imath(\delta,\sigma)+3\epsilon$. From continuity of $\widehat{u}_\imath$ and since $\sigma_n\to\sigma$, it follows that for n large enough, $u_\imath(\delta',\sigma_n)>u_\imath(\delta',\sigma)-\epsilon$. Combining the two preceding inequalities gives $u_\imath(\delta',\sigma_n)>u_\imath(\delta,\sigma)+2\epsilon$, and continuity of $\widehat{u}_\imath$ implies that $u_\imath(\delta,\sigma)+2\epsilon>u_\imath(\delta_n,\sigma_n)+\epsilon$. But $u_\imath(\delta',\sigma_n)>u_\imath(\delta_n,\sigma_n)+\epsilon$ contradicts $\delta_n\in B(\sigma_n)$. Hence, $B(\sigma)$ must have a closed graph.

From Kakutani's Fixed Point Theorem it then follows that there exists at least one $\sigma\in\Delta(K)^{\mathcal{I}}$ for which $\sigma\in B(\sigma)$, as desired. *Q.E.D.*

Appendix D: Variable Definitions

This appendix provides a description of all data used in the paper, as well as precise definitions together with the sources of all variables.

D.1. *Election Results*

Data containing the official results of the 1980, 1983, 1987, 1990, 1994, and 1998 federal elections by municipality (Gemeinde) as well as the 2002, 2005, and 2009 elections by polling precinct (Wahl-

[35] Note that (8) could have alternatively been expressed as

$$p(k,\tau|u,t)=\begin{cases} u_k & \text{if } \tau(k)\geq\tau(k')+1\ \forall k'\in K\setminus\{k\} \\ \frac{1}{2}(u_k-u_{k'}) & \text{if } \exists k'\in K \text{ s.t. } \tau(k')=\tau(k)\wedge\tau(k)\geq\tau(k'')\,\forall k''\in K\setminus\{k'\} \\ \frac{1}{2}(u_k-u_{k'}) & \text{if } \exists k'\in K \text{ s.t. } \tau(k')=\tau(k)+1\wedge\tau(k)\geq\tau(k'')\,\forall k''\in K\setminus\{k'\} \\ u_{k'} & \text{if } \exists k'\in K \text{ s.t. } \tau(k')>\tau(k)+1\wedge\tau(k')\geq\tau(k'')\,\forall k''\in K \end{cases}.$$

In (8) strategic voters care only about influencing the outcome of the election, whereas in the formulation above they derive utility from whichever candidate wins the elections. Since payoffs differ only by a constant, the two specifications are equivalent.

bezirk) have been purchased from the Federal Returning Officer. These data include information on the number of list and candidate votes for each party and each candidate, the number of eligible voters, as well as the number of valid and invalid votes. In 2009 there were approximately 89,000 precincts. Whenever necessary precinct level numbers are aggregated using the municipality identifiers contained in the raw data. Municipalities spanning multiple districts are discarded. Throughout the analysis the following variables are used:

Number of Eligible Voters is defined as the number of residents of each precinct that were allowed to vote in the particular year. In general this encompasses all German citizens over the age of 18, who have not been declared mentally unfit, or whose voting rights have not been suspended due to criminal behavior.

Turnout is defined as the number of actual voters over the number of eligible voters. This number cannot be calculated for absentee precincts, as absentee voters are included in the number of eligible voters in their district of residence. Hence, in-person turnout in each district needs to be adjusted for absentee voters. In practice, this is done by multiplying the number of issued absentee ballots by .95 (which corresponds to the empirical frequency with which they are cast) and adding them to the ballots that are cast in person.

Share of List Vote is defined as the portion of all valid list votes (in %) that are cast for a particular party. "Micro parties", i.e. those not clearing the 5%-threshold, are grouped together.

Share of Candidate Vote is defined as the portion of all valid candidate votes (in %) that are cast for the candidate of a particular party. Votes for candidates of "micro parties" are pooled.

Absentee Precinct is an indicator variable equal to one if a given precinct handles only absentee ballots.

D.2. *Candidate Characteristics*

Prior to every election to the Bundestag the Federal Returning Officer publishes information on certain characteristics of all official list and direct candidates. This paper focuses only on the latter. The data have been compiled from Bundeswahlleiter (2005c, 2009b). Throughout the analysis the following variables are used:

Age at the time of the election is defined as election year minus year of birth.

Female is an indicator variable equal to one if a candidate is female, and zero otherwise.

Doctorate is an indicator variable equal to one if a candidate holds a doctoral degree and/or a professorship, and zero otherwise. As doctoral degrees are part of Germans' official names, this variable has been created using a text search for "Dr." and "Prof.".

Currently Member of Parliament is an indicator variable equal to one if the candidate holds a list or direct mandate, and zero otherwise.

Holds Direct Mandate is an indicator variable equal to one if the candidate holds a direct mandate, and zero otherwise.

Also on Part List is an indicator variable equal to one if the candidate does not only run in the district race, but is also on her party's state list (and could thus enter the Bundestag either way).

Position on Party List denotes the candidate's rank on her party's state list (conditional on having been placed on the list).

D.3. *Municipality Characteristics*

Information on municipalities' demographic and socio-economic characteristics is taken from *Statistik lokal 2007* and *Statistik lokal 2011* (Statistische Ämter des Bundes und der Länder 2007, 2011). *Statistik lokal* is an annual publication of the German Federal Statistical Office and the statistical offices of the Länder containing data on various characteristics of approximately 12,000 municipalities and administrative units in Germany as of about 2 years before to the publication date. These data have been linked with the election results described above using the municipality identifier (Allgemeiner Gemeindeschlüssel) contained in both data sets. Below follows a brief description of all municipality level variables used throughout the analysis.

Population Density is defined as a municipality's total average population (in thousands) per square kilometer during the respective calendar year.

Fraction of Voters Female is defined as the share of women among a municipality's population over the age of 18.

Income Tax Revenue Per Capita is defined as the total income tax receipts (in 1,000 EUR) accruing to the respective municipality divided by its population during the same calendar year.

Fraction of Voters under Age 30 is defined as the fraction of individuals aged 18–30 among those over the age of 18.

Figure A.1: Ballot for the 2009 Federal Election (Electoral District 207)

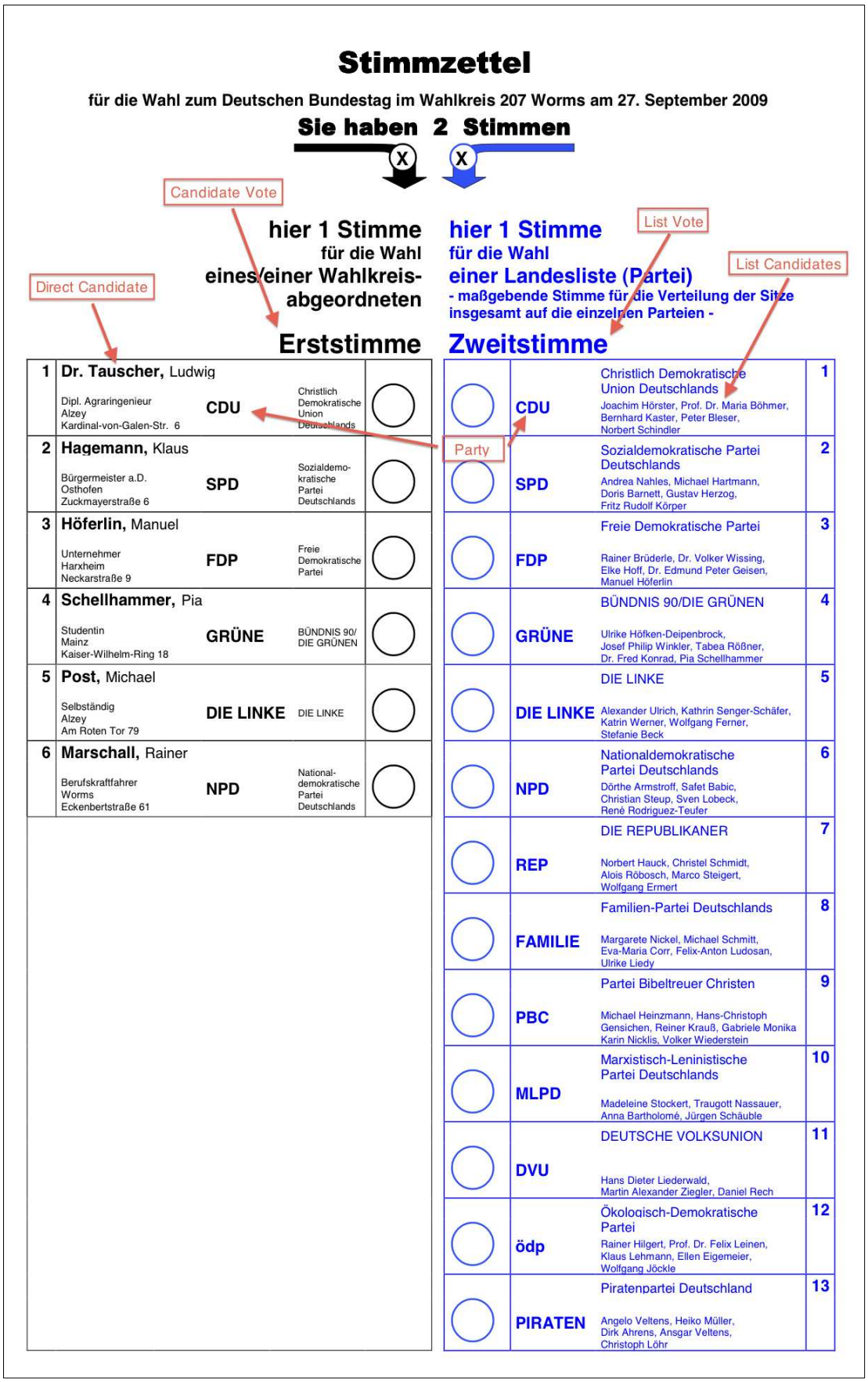
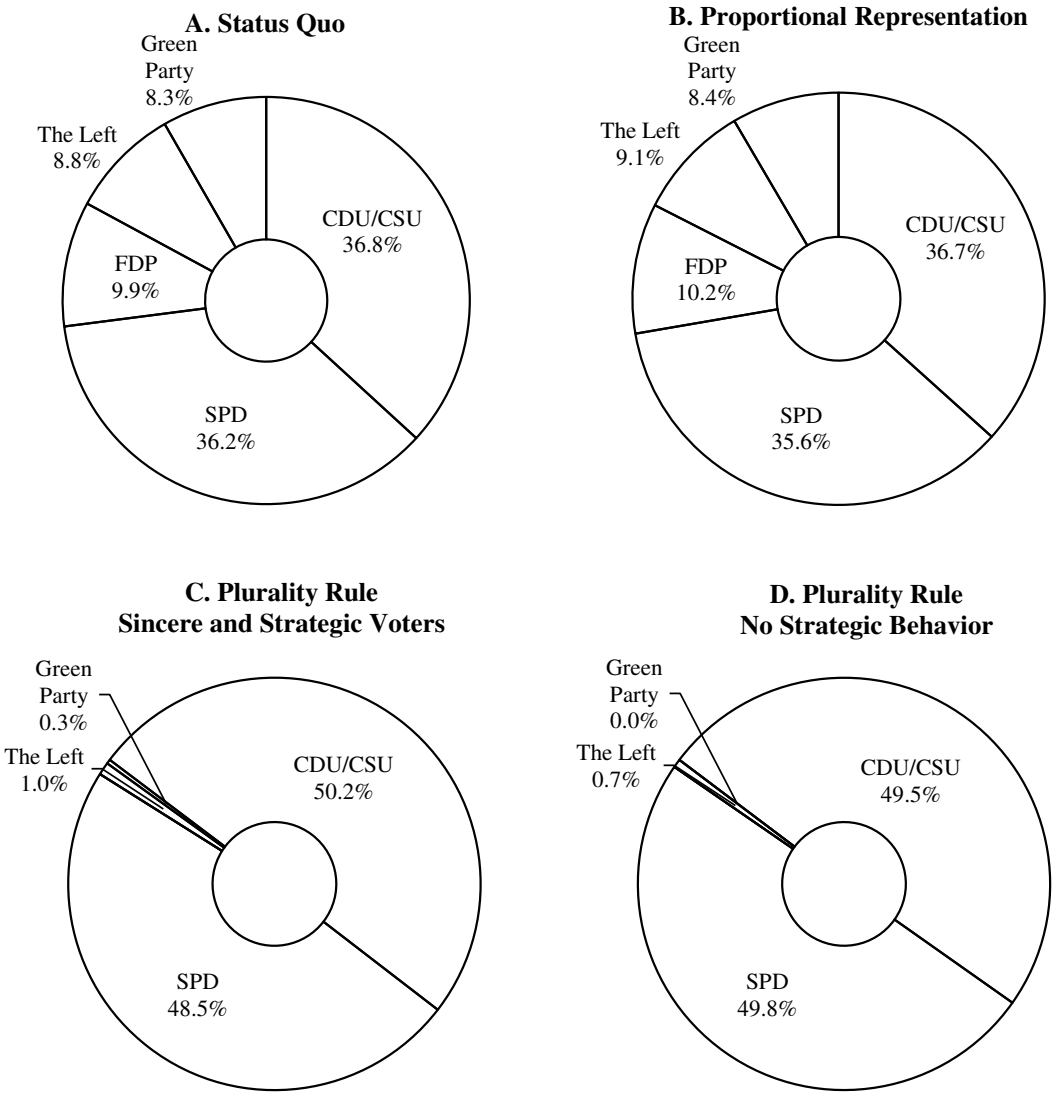
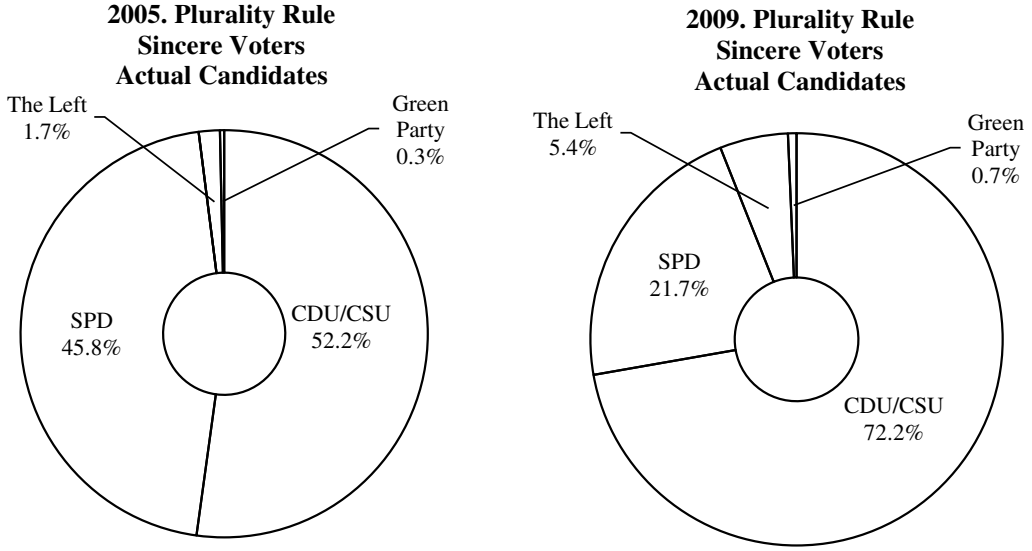


Figure A.2: Counterfactual Seat Distributions in the 16th Bundestag



Notes: Figure depicts counterfactual seat distributions in the Bundestag following the 2005 federal election. See the main text for a description of the assumptions underlying each panel.

Figure A.3: Counterfactual Seat Distributions in the 16th & 17th Bundestag



Notes: Figure depicts counterfactual seat distributions in the 16th (left panel) and 17th (right panel) Bundestag assuming plurality rule on the district level, sincere voting, and the actual set of candidates.

Table A.1: District Level Impact of Strategic Behavior, 2005 Federal Election

District Winner with No Strategic Behavior	District Winner in Current Equilibrium				
	CDU/CSU	SPD	FDP	The Left	Green Party
CDU/CSU	**47.49%**	2.01%	0.00%	0.00%	0.00%
SPD	2.68%	**46.49%**	0.00%	0.33%	0.33%
FDP	0.00%	0.00%	**0.00%**	0.00%	0.00%
The Left	0.00%	0.00%	0.00%	**0.67%**	0.00%
Green Party	0.00%	0.00%	0.00%	0.00%	**0.00%**

Notes: Entries compare the distribution of district winners in a first-past-the-post system with only sincere voters and no strategic nomination of candidates (left column) to the one that would obtain with a mixture of types and tactical nomination (top row). Summing across columns gives the percentage of districts that would acrue to a particular party if all voters behaved sincerely and if parties could not strategically nominate candidates, whereas summing across rows gives a party's share of districts in the current equilibrium. Consequently, adding the entries on the diagonal shows that almost 95% of districts would accrue to the same party.