Election Forensics: The Meanings of Precinct Vote Counts' Second Digits*

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Abstract

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Very recently there has been controversy about a method suggested for detecting election fraud: Pericchi and Torres argue that Benford's Law applied to the second digits of vote counts can be a standard for detecting fraud, while Deckert, Myagkov and Ordeshook argue that Benford's Law is useless for this purpose. Using data from elections from several countries and election systems I show that with precinct- or polling station-level vote counts, the so-called second-digit Benford's Law distribution (2BL) describes very few of the empirical distributions. Contra Pericchi and Torres, however, it is not that fraud is rife in all these elections. Instead the digits in vote counts can help diagnose both the strategies voters use in elections and nonstrategic special mobilizations affecting votes for some candidates. Using excerpts from my book manuscript *Election Forensics*, which examine data from elections in the United States, Germany, Canada and Mexico, I assess the performance of tests based on the second significant digits of precinct-level vote counts. The claim that deviations in vote counts' digits from the distribution implied by Benford's Law is an indicator for election fraud generally fails. With precinct vote counts, the second significant digits are sensitive both to imbalances in district preferences and to the strategies voters are using in the election as well as to other special mobilizations. All these produce systematic deviations from the distribution implied by 2BL. Similar patterns are observed in many elections in many countries when there is virtually no fraud.

1 Introduction: Conditional Digit Means

Mebane (2013) emphasizes how patterns in the conditional mean of the second significant digits of precinct vote counts—a statistic denoted $\hat{j}_x$ or $\hat{j}_{xy}$—help diagnose the strategies voters were using in several elections in the United States, Germany, Canada, Mexico and other places. The diagnostic use of the second digits of vote counts—in connection with Benford's Law and election fraud—seems to have first been suggested by Pericchi and Torres (2004), which met a skeptical response in Carter Center (2005)'s observation that the digits in vote counts do not follow Benford's Law.[1] The theme was taken up by Mebane (2006, 2012), and Mebane (2010*b*) used the so-called second-digit Benford's Law (2BL) to diagnose likely fraud in Iran's 2009 election. Pericchi and Torres (2011) claim that Benford's Law applied to vote counts' second digits provides a sufficient standard for diagnosing election fraud, and here again there are skeptical voices (Shikano and Mack 2009; López 2009; Deckert, Myagkov and Ordeshook 2011; Mebane 2011). Cantu and Saiegh (2011) find that Benford's Law approximately describes the first digits in some district-level election returns in some Argentine elections.

It is best to think of precinct vote counts as following not Benford's Law but rather distributions in families of Benford-like distributions. Vote counts are mixtures of several distinct kinds of processes: some that determine the number of eligible voters in each precinct; some for how many eligible voters actually vote; some for which candidate each voter chooses; some for how the voter's choice is recorded. Such mixtures can produce numbers that follow Benford-like distributions but not Benford's Law (Rodriguez 2004; Grendar, Judge and Schechter 2007). The following unconditional tests have been described as 2BL tests (Mebane 2006), but it is more precise (Mebane 2010*a*) to use 2BL to refer to second-digit Benford-like tests.

Unconditional tests for the second digits of vote counts come in two forms. One uses a Pearson chi-squared statistic: $X^2_{2BL} = \sum_{j=0}^{9}(n_j - Nr_j)^2/(Nr_j)$, where N is the number of vote counts of 10 or greater (so there is a second digit), n_j is the number having second digit $j \in \{0, 1, \ldots, 9\}$ and $r_j = \sum_{k=1}^{9}\log_{10}(1 + (10k + j)^{-1})$ is given by the Benford's Law formula. For independent vote counts, this statistic should be compared to the chi-squared distribution with nine degrees of freedom. To make this comparison Pericchi and Torres (2011) advocate using the significance probability $\alpha = (1 + [-ep\log(p)]^{-1})^{-1}$ (Sellke, Bayarri and Berger 2001, 62, equation 3), where p is p-value of X^2_{2BL}.[2] The second statistic, inspired by Grendar, Judge and Schechter (2007), is the mean of the second digits, denoted $\hat{j}$. If the distribution of the counts' second-digits has frequencies r_j as given by Benford's Law, then the second digits' expectation is $\bar{j} = \sum_{j=0}^{9} jr_j = 4.187$.

No formal theory exists to support interpretations of the patterns in the second

[1] Benford's Law describes a distribution of digits in numbers that arises under a wide variety of conditions. Statistical distributions with long tails (like the log-normal) or that arise as mixtures of distributions have values with digits that often satisfy Benford's Law (Hill 1995; Janvresse and de la Rue 2004). Under Benford's Law, the relative frequency of each second significant digit $j = 0, 1, 2, \ldots, 9$ in a set of numbers is given by $r_j = \sum_{k=1}^{9}\log_{10}(1 + (10k + j)^{-1})$ or $(r_0, \ldots, r_9) = (.120, .114, .109, .104, .100, .097, .093, .090, .088, .085)$.

[2] Pericchi and Torres (2011) use a modified statistic that adjusts for the maximum number of possible votes. An argument against their modification is that often the maximum is unknown or, as when there is voter registration, the maximum is random and endogenous to voting decisions and consequently it is unreasonable to condition on it.

significant digits of precinct vote counts, so the point of my efforts here is twofold. In one direction, my effort is an inductive effort to determine whether the second-digit patterns are in fact meaningful. In Mebane (2013) there is an extensive attempt to match statistics like the conditional digit mean $\hat{j}_x$ to known (or at least strongly substantiated) patterns of strategic and other normal political behavior by voters. Mebane (2013) finds that in several countries—with both plurality and mixed systems—the second significant digits of precinct or polling station vote counts behave in regular ways that match the strategies voters are using. But Mebane (2013) finds also that the digits respond not only to strategically induced additions and subtractions from the votes received by a party but also to changes that trace to other reasons for "especial mobilization." Mobilization by strategy is merely one type of mobilization that leaves regular traces in vote counts' digits.

In the current paper I use my judgments about the broad causes of voters' actions to interpret $\hat{j}_x$ statistics.

From the other direction, my interpretations are partly based on a simulation exercise reported in Mebane (2010*a*, 2012). Table 1 and Figures 1 and 2 summarize the findings from the simulation. Table 1 shows that when there is an election with three candidates in a single district and voters use wasted-vote logic to abandon the third-place candidate in order to support one of the top two candidates, the results is second-digit mean values near $\hat{j} = 4.35$. The simulation that produces Table 1 considers a district where the leading parties have roughly balanced support. Figure 1 summarizes a simulation in which there are exactly two parties but the balance of support for one party over the other varies from the balanced situation to a situation that is relatively lopsided. There is no strategic voting in this simulation. The conclusion is that district imbalance alone is enough to produce a typical pattern of variation in $\hat{j}_x$ when the conditioning variable x is the margin between the two candidates: by construction $\hat{j}_x = \bar{j} \equiv 4.187$ when $x = 0$;[3] in the presence of turnout decline,[4] $\hat{j}_x$ first rises as the margin increases and then declines such that eventually $\hat{j}_x < \bar{j}$. Figures 2(a,b) summarize a simulation with three parties, strategic vote switching and varying degrees of imbalance. The pattern in $\hat{j}_x$ varies between the leading and second-place parties and depending on whether there is "wasted-vote" strategic behavior. Figures 2(c,d) refer to a "coercion" condition.

*** Table 1 and Figures 1 and 2 about here ***

As I illustrate in the next section of this paper, the claim by Pericchi and Torres (2011) that Benford's Law applied to vote counts second digits provides a sufficient standard for diagnosing election fraud is almost certainly false, at least when precinct or polling station votes counts are considered (see also Deckert, Myagkov and Ordeshook 2011; Mebane 2011). For many elections and parties in several countries I show that the diagnostic statistic (α)[5] they favor shows extensive deviations from what Benford's Law implies. The deviations are caused by district imbalance, voters' strategies and other kinds of special mobilization that affect vote counts in normal elections.

[3]If the distribution of the vote counts' second-digits j is described by Benford's Law, then the second digits' expectation is $E[j] = 4.187$. For brevity I define $\bar{j} \equiv 4.187$.

[4]"Turnout decline" means that turnout decreases as the margin increases from zero. Turnout decline is well established as occurring both in the United States and Canada (Cox and Munger 1989; Berch 1989).

[5]But see note 2 on page 1.

Mebane (2013) shows that the simulated patterns often match the patterns observed in real data from many countries, notably the United States, Canada, Germany and Mexico. This paper largely consists of excerpts from Mebane (2013). Successive sections consider in turn data from the United States, Germany, Canada and Mexico. The match between simulated and real data patterns and the consequent intelligibility of the real patterns helps build an inductive case for the meaningfulness of precinct vote counts' second significant digits.

2 2BL and Precinct Vote Counts

The claim by Pericchi and Torres (2011) that failure of vote counts' second digits to match the distribution implied by Benford's Law provides a sufficient standard for diagnosing election fraud is almost certainly false, at least when precinct or polling station vote counts are examined. Consider the following examples of 2BL test statistics computed using precinct (or polling station) vote counts from the United States, Germany, Canada and Mexico. The data show extensive deviations from what Benford's Law implies. Mebane (2013) argues at length that the deviations are caused by district imbalance, voters' strategies and other kinds of mobilization that affect vote counts in normal elections. In these cases fraud has little to do with it (although the Mexican case is complicated due to vote buying).

The hypothesis that precinct vote counts follow the 2BL distribution is rejected when the hypothesis is tested using data from American federal and state legislative elections of 1984–1990.[6] For candidates affiliated with the Democratic and Republican parties, Table 2 reports χ^2_{2BL}, the corresponding significance probability α and $\hat{j}$. The hypothesis is rejected for all of the 28 test statistics shown in Table 2. In all but a few instances $\hat{j}$ differs significantly from $\bar{j}$.

*** Table 2 about here ***

The hypothesis that precinct votes counts are 2BL-distributed is also often rejected when the hypothesis is tested using data from American elections during the 2000s.[7] Table 3 reports χ^2_{2BL}, α and $\hat{j}$ for candidates affiliated with the Democratic and Republican parties. The hypothesis is rejected in nine out of ten instances for Democrats but is never rejected for Republicans. $\hat{j}$ differs significantly from $\bar{j}$ in every instance for the Democrats but never for Republicans. Mebane and Kent (2013) and Mebane (2013) argue that differences between Tables 2 and 3 trace to differences across the decades in the patterns of electoral mobilization by the political parties (see section 3.1 below).

*** Table 3 about here ***

In German Bundestag elections each voter casts two votes. *Erststimmen* (first votes) determine the winner of each *Wahlkreis* (district) through a plurality voting rule, and

[6]See note 15 on page 7 for data source information.
[7]See note 20 on page 9 for data source information.

Zweitstimmen (second votes) determine the overall share of the seats each party has in the Bundestag through proportional representation (PR) rules.[8]

The hypothesis that polling station vote counts are 2BL-distributed is usually rejected when the hypothesis is tested using data from the German Bundestag elections of 2002, 2005 and 2009 (see also Shikano and Mack (2009)).[9] The χ^2_{2BL}, α and $\hat{j}$ statistics do not vary substantially over the three years, so Table 4 reports statistics for the SPD, CDU/CSU, PDS/Linke and Green parties pooled over years.[10] The hypothesis fails to be rejected only for the Green *Erststimmen*. $\hat{j}$ differs significantly from $\bar{j}$ in all but one case for *Erststimmen* but for only two in five instances for *Zweitstimmen*. (Mebane 2012, 2013) argues that these deviations from 2BL can be explained by the effects on the digits of district imbalance, rolloff and strategic voting with the latter involving a combination of "wasted vote" reasoning and "threshold insurance" calculations (Gschwend 2007; Herrmann and Pappi 2008; Shikano, Herrmann and Thurner 2009) (see section 4.1 below).

*** Table 4 about here ***

The hypothesis that the polling station counts are 2BL-distributed is rejected for most parties most of the time when the hypothesis is tested using data from the Canadian federal elections of 1997–2011.[11]. Of the 32 test instances shown in Tables 5 and 6, the hypothesis is not rejected in only four instances: for the Progressive Conservatives in 1997, for NDP in 2004 and 2006, and for the Liberal party in 2011. $\hat{j}$ usually differs significantly from $\bar{j}$. Mebane (2013) argues that this pattern traces to the fact that Canadian voters usually act strategically—somewhat in accord with instrumental rationality (Blais and Nadeau 1996; Blais, Nadeau, Gidengil and Nevitte 2001; Chhibber and Kollman 2004) but without any nationally oriented coalition awareness (Blais and Gschwend 2011) (see section 5 below). The varying results for the Liberal party and for NDP reflect the former's decline and the latter's rise in 2011 to Official Opposition status (LeDuc 2005, 2007, 2009, 2012).

*** Tables 5 and 6 about here ***

Federal elections in Mexico since 1994 have been closely contested with both volatility in outcomes and frequent charges that election fraud was widespread, so it is controversial whether there is significant fraud in any recent elections. Fraud occurred in the presidential election of 1988 (Castañeda 2000, 80–87, 199; Magaloni 2006, 5). Allegations of fraud and postelection protests followed the elections especially of 1994 (McCann and Domínguez 1998), 2006 (Klesner 2007; López 2009) and 2012 (Sala Superior 2012*a*,*b*; Sandels 2012), although in these cases it is less clear whether substantial fraud actually occurred.

While it may be less a matter of consensus that Mexican elections are largely free of fraud than the elections we have examined from the United States, Germany or Canada, test results regarding the hypothesis that Mexican polling station counts follow the 2BL distribution are comparable to the results from those countries. Using for example data

[8]To receive seats through the PR process, a party must receive more than five percent of the valid *Zweitstimmen* or win three *Wahlkreise* based on *Erststimmen* (Bundeswahlleiter 2011*a*, Section 6).

[9]Data come from Bundeswahlleiter (2010*b*,*a*, 2011*b*).

[10]Here "Green" refers to *Bündnis 90/Die Grünen*.

[11]Data are from Elections Canada (2006*c*,*a*,*b*, 2010, 2012)

from the Mexican federal elections for *Presidente* and for *Diputados Federales* of 2006 and 2012, the hypothesis is rejected for most parties most of the time.[12]. Following the point made by Mebane (2006) that the *casilla* (ballot box) is too low a level of aggregation for 2BL tests to give meaningful results, I consider each of these counts aggregated to the *sección*, a small administrative unit usually containing several *casillas*. Of the 30 test statistics shown in Table 7 and 20 in Table 8, the hypothesis is not rejected in only 13 instances.[13] In 2012 these nonrejections include the parties or coalitions that finished in second (MP) and in third (PAN) place in the presidential election. For the winning party the 2BL hypothesis is always rejected. $\hat{j}$ usually differs significantly from $\bar{j}$. Mebane (2013) argues that these patterns reflect varying coalition formations and locally inflected patterns of strategic voting and vote buying (see section 6 below).

*** Tables 7 and 8 about here ***

The frequent—indeed, typical—rejections of the 2BL hypothesis in all these countries do not imply that election fraud is present in all these elections, as Pericchi and Torres (2011) might suggest. Instead the deviations from 2BL are caused by district imbalance, voters' strategies and other kinds of mobilization that affect vote counts in normal elections.

3 United States

In the United States the strategy of principal interest is the one described by the strategic party balancing theory of Alesina and Rosenthal (1995). That theory describes a relationship in presidential election years between votes cast for president and votes cast for the U.S. House of Representatives, and it makes predictions for how the votes cast in midterm elections should be distributed. The theory asserts that strategic considerations should cause the leading presidential candidate to receive some votes that the candidate would not otherwise receive while at the same time legislative candidates from the opposing party receive extra votes that they would not have otherwise received. Mebane (2013) describes these "extra" votes as being strategically switched toward the favored candidates, even though in a literal sense—according to the theory—the vote gains the candidates enjoy reflect merely the impetus that occurs as part of large-scale noncooperative equilibrium behavior. A main point in Mebane (2013) is that $\hat{j}_x$ behaves in ways that are compatible with the gains the respective parties are predicted to receive in the designated

[12]Data are from Instituto Federal Electoral (2006, 2012*d*). Results from 1994 and 2000 are similar.

[13]The parties and coalitions shown in Tables 7 and 8 are as follows: APM, coalición Alianza por México (PRI, PVEM); ASDC, Partido Alternativa Social Democrática y Campesina; CAC, coalición Alianza por el Cambio (PAN, PVEM); CAM, coalición Alianza por México (PRD, PT, Convergencia, Partido Alianza Social, Partido de la Sociedad Nacionalista); CM, coalición Compromiso por México (PRI, PVEM); DSPPN, Democracia Social Partido Politico Nacional; MP, coalición Movimiento Progresista (PRD, PT, Movimiento Ciudadano); NA, Partido Nueva Alianza; PAN, Partido Acción Nacional; PARM, Partido Auténtico de la Revolución Mexicana; PBT, coalición Por el Bien de Todos (PRD, PT, Convergencia); PCD, Partido Centro Democrático; PDM, Organizacion Politica Uno Partido Demócrata Mexicano; PRD, Partido de la Revolución Democrática; PPS, Partido Popular Socialista; PRI, Partido Revolucionario Institucional; PRN, Partido del Frente Cardenista de Reconstrucción Nacional; PT, Partido del Trabajo; PVEM, Partido Verde Ecologista de México.

time periods. In midterm elections, when Alesina and Rosenthal's theory predicts voters do not strategically switch their votes, $\hat{j}_x$ has patterns that can be explained almost entirely as consequences of partisan imbalances among the voters in each of the different districts.

While extensive evidence ranging from macroeconomic data (Alesina, Londregan and Rosenthal 1993; Alesina and Rosenthal 1995) to survey data (Mebane 2000; Mebane and Sekhon 2002) supports the validity of the Alesina and Rosenthal model during the 1980s, which is the time period covered by the analysis in Mebane (2013, Chapter 10), whether the same mechanisms operate in subsequent American national elections is more of an open question. Looked at from a distance, events give reason to question whether major predictions of the theory hold. Alesina and Rosenthal's theory predicts that the president's party regularly experiences a midterm loss, but both in 1998 and in 2002 the president's party gained vote share in midterm House elections. For 1998, Mebane and Sekhon (2002) suggests how that might occur even if the structure of the election is as Alesina and Rosenthal (1995) describes: Mebane and Sekhon (2002) point out that there are regular fluctuations in policy preferences that usually go against the president's party but in 1998 did not. In the 2006 and 2010 elections midterm losses by the president's party resumed. In the preceding presidential contests (2004 and 2008 respectively), same-party majorities and executives were elected, only to have presidential approval fall precipitously prior to the ensuing midterm election. Just before the 2006 election George W. Bush's approval rating sat at 38%; Barack Obama's approval rating was 43% on the eve of the 2010 midterm.[14]

The 2006 and 2010 elections seem in many ways to be mirror images of one another. After the 2006 election Democrats had gained 31 seats in the House and held a 31 seat advantage; after the subsequent midterm, Republicans had gained 63 seats and held a 49 seat advantage. Contested policy issues haunted each President and their legislative majorities. In 2006 war weariness was a major topic in the campaign, while in 2010 the recent passage of the Affordable Care Act weighed heavily upon Democratic prospects. Because these two elections with midterm losses follow two elections in which there were no losses, we can wonder whether the mechanisms that generate the losses differ from the reasons for losses in the earlier period.

Similarities between 2006 and 2010 reach beyond federal elections. As a result of the 2006 election Democrats gained six governorships, and four years later Republicans gained six. The 2006 election saw substantial gains for Democrats in state legislatures, with no chambers switching from Democratic to Republican control, and in 2010 Republicans made huge gains in state legislative control with no chambers switching from Republican to Democratic control. These are the only two times such uniformly directed changes have happened since the Republican victories of 1994 (O'Toole 2010; Geller 2006).

Other seeming anomalies relative to the strategic party balancing theory appear if I use data from U.S. elections during the 2000s to compute the conditional means of the second significant digits of precinct vote counts ($\hat{j}_x$). Ultimately I find that for U.S. House races the midterm elections of 2006 and 2010 seem remarkably like the presidential year elections of 1984 and 1988 and unlike the midterms of 1986 and 1990. Patterns in $\hat{j}_x$ for state legislative elections in 2006, 2008 and 2010 track the patterns for U.S. House races, something that does not happen in the elections of the 1980s.

[14]Source: `http://www.presidency.ucsb.edu/data/popularity.php`.

3.1 United States in the 2000s

A baseline for my treatment of elections in the 2000s is the set of patterns observed for elections during the 1980s. In these years a major feature is that the pattern in $\hat{j}_x$ varies substantially between presidential and midterm election years. Consider for instance the contrast between Figures 3 (for presidential year 1984) and 4 (for midterm year 1986).[15] In each figure the conditional mean of the second significant digits is shown separately in four categories. Clockwise from the upper left in the display these are means for the Republican candidate in districts where the Republican won, for the Republican candidate in districts where the Democrat won, for the Democratic candidate in districts where the Democrat won and for the Democratic candidate in districts where the Republican won. Each x-axis contains and each rug plot displays the absolute margin in each legislative district.[16] I use $\mathfrak{M}_{12}$ to refer to this absolute margin in the text. Each plot shows a nonparametric regression curve (Bowman and Azzalini 1997) that indicates how the mean of the second digit of the vote counts for the candidates in each category varies with $\mathfrak{M}_{12}$.[17] I use $\hat{j}_x$ to denote this conditional mean. $\hat{j}_x$ is shown surrounded by 95 percent confidence bounds. A question in all the plots is whether $\bar{j}$, indicated by a horizontal dotted line in the plots, falls outside the confidence bounds. In such cases I say $\hat{j}_x$ differs significantly from $\bar{j}$.

*** Figures 3 and 4 about here ***

A difference between the figures for the two election years is apparent especially for winning Democratic candidates (Figures 3(d) and 4(d)). In Figure 3(d) for presidential year 1984 $\hat{j}_x > \bar{j}$ significantly over all of the distribution for Democratic winners, while in Figure 4(d) for midterm year 1986 $\hat{j}_x$ is mostly not significantly different from $\bar{j}$ and $\hat{j}_x > \bar{j}$ significantly only for a few intermediate values of $\mathfrak{M}_{12}$. Not much of a difference between years is apparent for Republican winners. Both in Figure 3(a) and Figure 4(a), $\hat{j}_x$ does not differ significantly from $\bar{j}$ for $\mathfrak{M}_{12}$ near zero or for the higher $\mathfrak{M}_{12}$ values, but $\hat{j}_x > \bar{j}$ significantly for intermediate $\mathfrak{M}_{12}$ values.

Mebane (2012, 2013) explains these differences across years and party affiliation for winning candidates as consequences of the operation of the mechanism identified by Alesina and Rosenthal (1995, 1996). To simplify slightly, according to that mechanism we should observe strategically switched votes being added to the vote counts of legislative candidates only of the party opposite that of the winning presidential candidate. Given that a Republican candidate won the presidency in 1984, the simulated digit means in Table 1 and in Figure 1 suggest that the patterns in Figures 3(a,d) and 4(a,d) diagnose the kind of strategic behavior the Alesina and Rosenthal model predicts. In Figure 3(d), $\hat{j}_x$ has values of about 4.35 for the whole distribution of winning Democratic candidates, a value that matches the value observed in Table 1 for the simulated cases of parties gaining from

[15] I have precinct data from U.S. House and state legislative elections in 1984, 1986, 1988 and 1990. 1984 U.S. data come from the Record of American Democracy (ROAD) (King, Palmquist, Adams, Altman, Benoit, Gay, Lewis, Mayer and Reinhardt 1997) and from Office of the Clerk (2010). The data include every state except California.

[16] In legislative races the margin is the difference between shares of the district two-party vote. Margins are based on district vote totals in documents available from Office of the Clerk (2010).

[17] Nonparametric regressions are computed using the `sm` package of **R** (R Development Core Team 2011).

strategically switched votes. In Figure 3(a), for winning Republican candidates $\hat{j}_x$ closely resembles the pattern observed for simulated winners with district imbalance and turnout decline in Figure 1(b). In 1984 the conditional digit means give evidence of asymmetric strategic behavior. In contrast in the midterm year, 1986, Figures 4(a,d) show no departures of $\hat{j}_x$ from $\bar{j}$ that cannot be explained as a result solely of district imbalance and turnout decline without any strategically induced vote changes (Figure 1(b)).

For losing (second-place) major party candidates, Figures 3(b,c) and 4(b,c) have $\hat{j}_x$ patterns that match the simulated pattern in Figure 2(a). The diagnosis in this case is that, as in the simulation, the patterns in the real data arise solely because of district imbalance and turnout decline without any strategically induced vote changes. The question why the patterns for these losing candidates resemble the pattern from the three-party simulation that produces Figure 2(a) and not the two-party simulation that produces Figure 1(b) has a nuanced answer that refers to the frequent presence of third-party candidates on the ballot for House elections.[18]

Qualitatively similar patterns are observed in data for U.S. House races from 1988 and 1990. For Democratic winners in 1988 (Figure 5(d)) $\hat{j}_x > \bar{j}$ for all $\mathfrak{M}_{12}$ values, matching the 1984 pattern shown in Figure 3(d) and testifying to the action of strategically induced gains. For Democratic winners in 1990 (Figure 6(d)) and for Republican winners both in 1988 (Figure 5(a)) and in 1990 (Figure 6(a)), $\hat{j}_x$ has a pattern like that in Figure 1(b), which suggests no strategic gains add to these candidates' vote totals. And $\hat{j}_x$ for second-place finishers in 1988 (Figures 6(b,c)) has patterns like those in Figure 2(a) while $\hat{j}_x$ for second-place finishers in 1990 has patterns somewhere between those in Figures 2(a,b).

*** Figures 5 and 6 about here ***

State legislative races during the 1980s give scant evidence of entanglement with the strategically induced variations in support for the parties that is apparent in the data from U.S. House races. Clearly in 1984, the patterns in $\hat{j}_x$ for winning Republican and Democratic state House candidates (Figures 7(a,d)) resemble the simulated patterns in Figure 1(b) in which variations in $\hat{j}_x$ relative to $\bar{j}$ arise due solely to district imbalance and turnout decline. For second-place Republican and Democratic state House candidates (Figures 7(b,c)) $\hat{j}_x$ resembles the simulated pattern in Figure 2(a), which again does not involve any strategically induced vote switching. The patterns in $\hat{j}_x$ for the state Senate races in 1984 (not shown) are similar. The difference that matters the most here is the contrast between $\hat{j}_x$ for Democratic winners in state House races (Figure 7(d)) and $\hat{j}_x$ for Democratic winners in U.S. House races (Figures 3(d)): the strategically induced variation in $\hat{j}_x$ that appears in the latter is not at all apparent in the former.

*** Figure 7 about here ***

[18]A discussion of this point goes beyond the scope of the current context, but for instance consider that in 1986 the sum of the votes for the Democratic or Republican candidates was less than the total number of votes in 222 of the 407 districts with vote totals reported at Office of the Clerk (2010). That is 55 percent of the districts with a third-party or write-in candidate. The mean share of the votes for the two major parties in those 222 districts was 96.10 percent (median 98.58 percent).

The patterns in $\hat{j}_x$ for state legislative races in the midterm elections of 1986 and 1990 similarly show no evidence of strategically induced behavior among the vote counts for winning candidates. The patterns in $\hat{j}_x$ for winning Republican and Democratic state House candidates (Figures 8(a,d) and 9(a,d)) resemble the simulated patterns in Figure 1(b). For second-place Republican and Democratic state House candidates (Figures 8(b,c) and 9(b,c)) $\hat{j}_x$ resembles a mix of the simulated patterns in Figures 2(a,b), echoing what was observed in the same years in data from U.S. House races (recall Figures 4(b,c) and 6(b,c)). Patterns in data for state Senate elections in these same years (not shown) are similar.

*** Figures 8 and 9 about here ***

In 1988 votes for one party show signs that could be interpreted as showing the state-level votes are aligned with the federal election. The pattern in $\hat{j}_x$ for Democratic winners is unlike the patterns observed in 1984 or 1986. For winning Democratic state house candidates, $\hat{j}_x$ is significantly greater than $\bar{j}$ when $\mathfrak{M}_{12} \approx 0$ (Figure 10(d)). For these candidates, however, usually $\hat{j}_x < 4.35$ significantly.[19] $\hat{j}_x$ for winning Democratic state senate candidates (not shown) is similar. According to Table 1, $\hat{j}_x \approx 4.35$ would suggest that votes are being added to the Democratic winning candidates perhaps for strategically induced reasons, but the simulation supports a different interpretation for values $\bar{j} < \hat{j}_x < 4.35$. The lower $\hat{j}_x$ values may suggest that each of those candidates tends to have ideologically similar third-party opposition (see Mebane (2012, 2013) for further discussion).

*** Figure 10 about here ***

For Republican state legislative candidates in 1988 there is nothing to suggest special strategic or other mobilization. The patterns in $\hat{j}_x$ for Republicans in 1988 are similar to the patterns seen in 1984 and 1986: for winners the patterns resemble the pattern in the nonstrategic, two-party simulation (compare Figure 10(a) to Figure 1(b)); for second-place finishers $\hat{j}_x$ is equal to slightly less than $\bar{j}$ (Figure 10(b)). $\hat{j}_x$ for Democratic second-place finishers is similar to the patterns observed for second-place candidates in 1984 and 1986 as well (Figure 10(c)).

3.2 2006

Compare $\hat{j}_x$ for U.S. House elections in 2006, in Figure 11, to $\hat{j}_x$ for U.S. House elections in 1986, in Figure 4.[20] In discussing the 1986 U.S. House results, I noted that there were no

[19] In Figure 10d, $\hat{j}_x$ is not significantly less than 4.35 only when $.63 < \mathfrak{M}_{12} < .67$.

[20] For several states I have precinct vote count data for the U.S. House elections of 2006, 2008 and 2010, as well as precinct data for state legislative elections. Data come from 36 states in 2006, 40 states in 2008 and 31 states in 2010. Data from 2006, 2008 and 2010 were collected by the author. The states with data in 2006 are AL, AK, AZ, AR, CA, CT, DE, FL, GA, HI, ID, IA, KS, LA, ME, MD, MI, MN, MS, MT, NE, NH, NY, NC, ND, OH, OK, PA, RI, SC, TN, TX, VT, VA, WI and WY. The states with data in 2008 are AK, AZ, AR, CA, CT, DC, DE, FL, GA, HI, ID, IL, IN, IA, KS, LA, ME, MD, MI, MN, MS, NH, NM, NY, NC, ND, OH, OK, PA, RI, SC, SD, TN, TX, VT, VA, WA, WV, WI and WY. The states with data in 2010 are AK, AZ, AR, CA, DC, DE, FL, GA, HI, ID, IL, IA, KY, ME, MD, MI, MN, MT, NC, NH, NM, OH, OK, RI, SC, TN, TX, VT, VA, WI and WY. U.S. House and president margins are computed using files obtained from Office of the Clerk (2010). Data are not available for every precinct in some states.

departures of $\hat{j}_x$ from $\bar{j}$ that cannot be explained as a result of district imbalance and turnout decline. I noted that such a lack of evidence of strategic behavior in 1986 matches what the strategic party balancing theory of Alesina and Rosenthal (1995) implies. In 2006 the patterns in $\hat{j}_x$ are similar to those in 1986 with one exception. The exceptional case concerns Democratic winners. In 2006 $\hat{j}_x$ for Democratic winners is significantly greater than $\bar{j}$ for $\mathfrak{M}_{12} < .7$, then $\hat{j}_x$ decreases as $\mathfrak{M}_{12}$ increases until $\hat{j}_x < \bar{j}$ significantly for the very highest observed $\mathfrak{M}_{12}$ value (Figure 11(d)). In 1986 $\bar{j}_x > \bar{j}$ significantly only when $0.3 < \mathfrak{M}_{12} < 0.35$, and for $0.3 < \mathfrak{M}_{12} < 0.35$ the lower bound of the confidence interval for $\bar{j}_x$ exceeds $\bar{j}$ in 1986 by only a tiny amount (Figure 4(d)). $\hat{j}_x$ in 2006 might be viewed as similar to the pattern for winning Democratic state House candidates in 1990, except that $\hat{j}_x$ in 2006 does not differ significantly from $\hat{j}_x \approx 4.35$ for $\mathfrak{M}_{12} < .7$ while in 1990 $\hat{j}_x < 4.35$ significantly for almost all values of $\mathfrak{M}_{12}$. According to the simulation results summarized in Table 1, the 2006 $\hat{j}_x$ values suggest especially mobilized vote gains for the Democratic winners while the 1990 $\hat{j}_x$ values need not.

*** Figure 11 about here ***

There are no major differences between 2006 and 1986 for other classes of vote counts. For winning Republicans in 2006, $\hat{j}_x$ does not differ significantly from $\bar{j}$ for higher $\mathfrak{M}_{12}$ or $\mathfrak{M}_{12}$ near zero, but $\hat{j}_x > \bar{j}$ significantly for intermediate $\mathfrak{M}_{12}$ values (Figure 11(a)). The pattern is similar to the one for winning Republicans in 1986 (Figure 4(a)). For second-place Republicans in 2006, $\hat{j}_x$ is not significantly different from $\bar{j}$ for values of $\mathfrak{M}_{12}$ near zero but is significantly below $\bar{j}$ at high values (Figure 11(b)). This pattern is similar to the pattern observed for both Republican and Democratic second-place finishers in 1986 (Figures 4(b,c)). For second-place Democrats in 2006 $\hat{j}_x$ is the same as in 1986 for low $\mathfrak{M}_{12}$, but for higher $\mathfrak{M}_{12}$ in 2006 $\hat{j}_x < \bar{j}$ but not significantly. This small difference between 2006 and 1986 for second-place Democrats probably should not affect the interpretation of voters' strategies in the two years.

The pattern differs from the earlier midterm year in that $\hat{j}_x$ in Figure 11(d) is not like $\hat{j}_x$ in Figure 4(a): the pattern for Democratic winners in 2006 is not the same as the pattern for Democratic or Republican winners in 1986. While for high $\mathfrak{M}_{12}$ values $\hat{j}_x$ in Figure 11(d) may seem not all that different from the 1986 Republican winners pattern in Figure 4(a), it differs significantly for $\mathfrak{M}_{12} \approx 0$. In 1986, $\hat{j}_x$ for either Democratic or Republican winners clearly does not differ significantly from $\bar{j}$ when $\mathfrak{M}_{12} \approx 0$, but in 2006 (Figure 11(d)) $\hat{j}_x > \bar{j}$ significantly when $\mathfrak{M}_{12} \approx 0$. This may suggest that there is strategic behavior in U.S. midterm elections. Any such behavior would not be implied by the strategic party balancing theory of Alesina and Rosenthal (1995).

$\hat{j}_x > \bar{j}$ significantly when $\mathfrak{M}_{12} \approx 0$ in 2006, which means that this $\hat{j}_x$ is not like $\hat{j}_x$ simulated for the advantaged candidate with no strategic behavior in Figure 1(b): $\hat{j}_x$ for Democratic winners in U.S. House elections in 2006 show some signs of those candidates benefiting from some kind of special mobilization. The pattern in the simulations that is closest to $\hat{j}_x$ in Figure 11(d) might be thought to be $\hat{j}_x$ for the advantaged candidate with no strategic behavior in either of Figures 2(a,c). U.S. House elections are not purely bipartisan in many districts in 2006,[21] so the conditions for the simulation that produces

[21] According to Miller (2007), third-party, write-in or scattering votes were recorded for 67 percent of House districts in 2006.

Figures 2(a,c) may not apply everywhere. But $\hat{j}_x$ in Figure 11(d) for $.06 < \mathfrak{M}_{12} < .85$ is significantly greater than the simulated $\hat{j}_x$ in Figures 2(a,c) for simulated advantage greater than .06 and less than .6. Of course the simulated "advantage" in Figures 2(a,c) is not the same as $\mathfrak{M}_{12}$ in the real data, but $\mathfrak{M}_{12}$ should increase monitonically as "advantage" increases. Moreover $\hat{j}_x$ in Figure 11(d) does not differ substantially from $\hat{j}_x \approx 4.35$ for $\mathfrak{M}_{12} < .75$.[22] So we may suspect that $\hat{j}_x$ in Figure 11(d) is picking up on some kind of special mobilization toward Democratic candidates.

Evidence does suggest that a special kind of mobilization benefited winning Democratic U.S. House candidates in 2006. Of course the Democratic party gained by receiving 6,407,503 more votes nationally than the Republican party did for U.S. House candidates in 2006 while in 2004 the Democratic party received 2,968,291 fewer votes than the Republican party did (Trandahl 2005; Miller 2007).[23] The mobilization is "special" in the sense that it apparently affects $\hat{j}_x$, but it is special also in the sense that it goes with variation in the distribution of voters that raises questions about whether in a technical sense the theory of Alesina and Rosenthal (1995) applies to the 2006 midterm election. That theory assumes that the proportion of the electorate with policy preferences ("ideal points" in a one-dimensional policy space) located between the policy positions of the two parties is constant between the presidential election and the following midterm (Alesina and Rosenthal 1996, 1328).[24] In fact the proportion seems to have changed between 2004 and 2006.

The admittedly weak evidence for this conclusion comes from Election Weekend surveys conducted by the Pew Research Center for the People & the Press (Pew Research Center 2004*a*, 2006*a*). These are surveys of American adults conducted the weekend before the fall general elections. The surveys include scales used to determine whether each survey respondent is a "likely voter" (Pew Research Center 2004*b*, 2006*b*). I use the likely voter scales to define weights so that the proportions of likely voters in the surveys equal the actual proportions of the voting age population turning out in the elections. I estimate the percentage of likely voters in each of six categories of "political views" ("Very Liberal" to "Very Conservative", plus "Don't Know/Refused") and compute difference in the percentages between presidential and midterm years. The results, in Table 9, show that a significantly higher percentage of likely voters say they are "Moderate" in the midterm election than in the preceding presidential election. The difference is about 7.5 percent. Significantly more likely voters say they are "Conservative" in the presidential election than in the midterm election. This difference is about five percent. The percentage who say "Don't Know" or who refuse to state a political view is significantly higher—by about 1.9 percent—in the presidential election year than in the midterm. None of the other differences between years are significant.

*** Table 9 about here ***

[22]The upper confidence bound of $\hat{j}_x$ in Figure 11(d) is always greater than 4.31 when $\mathfrak{M}_{12} < .75$.

[23]In 2006 a total of 80,975,537 votes are counted for a U.S. House candidate while in 2004 there are 113,192,286 votes counted for a candidate (Miller 2007; Trandahl 2005).

[24]Specifically, a key assumption of the formal theory is "there is always a constant proportion $(\theta_d - \theta_R)$ of the electorate with ideal points in the interval $[\theta_d, \theta_R]$" (Alesina and Rosenthal 1996, 1328).

The apparent increase in the number of "Moderates" and decrease in the number of "Conservatives" echoes the pattern documented for 1978–1994 by Mebane and Sekhon (2002), wherein the electorate's policy positions tend to move away from the president's party at midterm. This statement depends on stipulations about the locations of the Democratic and Republican parties' policy positions. The Pew surveys do not ask respondents to state policy positions or "views" for the parties, so evidence about those positions to compare to likely voters' views in the Pew data must come from another source. I refer to the estimates of Mebane (2000, 53, Table 6), based on data from the American National Election Studies of 1976–1996, which show that about one-quarter of voters have positions more extreme in either direction than the respective parties' positions. Applying this to the Pew data, in the parlance of the "views" measured by Pew, about a quarter of the likely voters in the presidential election are more conservative than the Republican party and about a quarter are more liberal than the Democratic party.[25] Based on the marginal distribution estimated for "views" in the 2004 Pew data and treating the categories from "Very conservative" to "Very liberal" as ordered, the Republican party position is somewhere in the "Conservative" category while the Democratic party position is somewhere in the "Moderate" category.

The increase in the percentage of likely voters saying they are "Moderate" violates the key assumption in the theory of Alesina and Rosenthal (1995, 1996) if the increase means that more voters' policy positions are located between the parties' positions at midterm than in the preceding presidential election. The Pew data do not provide enough information to say for sure whether such an increase occurs—and that is the fundamental weak spot in this analysis—but the data also do not contradict the occurrence of such an increase. The meaning of the categories remains the same between the elections, at least in the sense that vote intentions depend on the political view categories in the same way across the two elections. A logistic regression of vote intentions on political view category shows no significant difference between presidential and midterm election years. When data are pooled across years and differences in effects are allowed by means of interactions with a midterm-election dummy variable, none of the interaction terms are significant (see Table 10). So it seems that the party positions remained the same even while the distribution of likely voter political views shifted.

*** Table 10 about here ***

To put the survey results for the 2004–2006 presidential-midterm election pair into some perspective, compare them to the elections that precede and follow them. As Table 11 shows, in 2002 the distribution of political views among likely voters does not differ from the distribution in 2000. Table 11 also shows that in 2010 the distribution of views includes significantly more "Very Conservative" likely voters than does the distribution in 2008. In 2008 there are more likely voters whose views are "DK/Refused" than there are in 2010.[26] The different profiles describe two sharply different patterns of gains in the

[25] Note that the methods used to estimate positions in Mebane (2000) are based on vastly more information than is available in the Pew data. Mebane (2000) defines voter-specific party positions and features other complications.

[26] The 90% confidence interval for the "DK/Refused" difference in Table 11 is $(.0011, .0296)$.

midterm elections. The Republican party gains slightly in 2002: the party's national advantage over the Democratic party in votes received by candidates for the U.S. House is 3,449,128 (out of a total 74,706,555 votes counted for some U.S. House candidate) in 2002 compared to only 338,616 (out of 98,799,963) in 2000 (Trandahl 2001, 2003). In contrast in 2010 the party gains tremendously: the national advantage over the Democratic party is 5,739,207 (out of 86,784,957) in 2010 compared to finishing behind the Democrats by 12,935,109 votes (out of 122,586,293) in 2008 (Miller 2009; Haas 2011). That's a difference of 4.3 percent in 2000–2002 but of 17.2 percent in 2008–2010.

*** Table 11 about here ***

In electoral terms the meaning of the different political views remains mostly the same between 2000 and 2002 but changes significantly between 2008 and 2010. Again I use the stability of vote intentions as functions of political view categories as the standard for constancy of meaning. Table 12 shows that in the logistic regression of vote intentions on political view category there are only two significant differences between 2000 and 2002. In 2002 the chances that a "Very Liberal" likely voter chooses a Democrat instead of a Republican substantially increase compared to 2000, and a likely voter whose views are "DK/Refused" has an increased chance of supporting the Republican.[27] None of the other interaction terms involving the midterm-election dummy variable are significant. In 2010 all types of likely voters except those whose views are "Very Liberal" have increased chances of supporting a Republican instead of a Democrat. The baseline Midterm interaction term is significantly negative. But "Very Conservative" likely voters are especially more likely to support a Republican. "Liberal" likely voters are as well.[28] The effect of the Tea Party and a more general disenchantment with Democratic candidates in 2010 is apparent (Leibovich and Parker 2010). A sign of the increased polarization in 2010 is that a "Very Liberal" likely voter may be more likely than in 2008 to choose the Democrat instead of the Republican.[29]

*** Table 12 about here ***

The 2006 election resembles 2010 in having a volatile distribution of political views, but it resembles 2002 in having views that have the same meaning, in terms of vote intentions, as during the preceding presidential election. Not having precinct election returns from 2002 unfortunately makes it impossible to investigate whether the differences among these elections also manifest in the distributions of the respective vote counts' digits. I return to the case of 2010 further below.

Signs that the 2006 election features a special increase in the number of voters supporting winning Democratic candidates also appear in that year's state legislative

[27]The 90% confidence interval for the Midterm interaction of the "DK/Refused" category in Table 12 is $(-1.82, -.0918)$.

[28]The 90% confidence interval for the Midterm interaction of the "Liberal" category in Table 12 is $(-1.56, -0.0066)$.

[29]The 90% confidence interval for the Midterm interaction of the "Very Liberal" category in Table 12 is $(.129, 2.90)$. This effect is probably at least as large as than the baseline Midterm interaction, for which the 90% confidence interval is $(-.679, -.0985)$.

elections.[30] Using vote counts from state House elections in 2006 to estimate $\hat{j}_x$, $\hat{j}_x$ for Republicans in districts where the Republican won (Figure 12(a)) resembles $\hat{j}_x$ for Republicans estimated using the state legislative elections of the 1980s (Figures 7(a), 8(a) and 10(a)). For the 2006 Republican winners, $\hat{j}_x > \bar{j}$ significantly only for an intermediate set of $\mathfrak{M}_{12}$ values, as is true in the 1980s data. $\hat{j}_x$ for Democratic second-place finishers is also similar across the years: $\hat{j}_x$ both in 2006 (Figure 12(c)) and in the 1980s and 1990 data (Figures 7(c) and 8(c)) is significantly less than $\bar{j}$ for intermediate $\mathfrak{M}_{12}$ values but not for $\mathfrak{M}_{12} \approx 0$ or for the highest observed $\mathfrak{M}_{12}$. The pattern in $\hat{j}_x$ for Republican second-place finishers in 2006 (Figure 12(b)) is like the pattern in the same year for Democratic second-place finishers. $\hat{j}_x$ for winning Democratic state house candidates resembles the pattern for winning Democratic state house candidates in 1988 (Figure 10(d))—indeed, even more the 2006 pattern resembles that for winning Democratic candidates for the U.S. House in 1988 (Figure 5(d)): $\hat{j}_x$ is persistently greater than $\bar{j}$ and often is not substantially different from $\hat{j}_x \approx 4.35$.

*** Figure 12 about here ***

Signs of special mobilization in favor of Democratic winners in the state senate elections are more ambiguous. $\hat{j}_x$ estimated using results from state senate elections in 2006 resemble the results from that year's state house elections. $\hat{j}_x$ for Republicans and for second-place Democrats generally resemble the patterns in $\hat{j}_x$ seen for house candidates, which suggest the occurrence of nonstrategic behavior (Figures 13(a–c)). $\hat{j}_x$ for winning Democrats is greater than $\bar{j}$ when $\mathfrak{M}_{12} < .85$ although not significantly so when $\mathfrak{M}_{12} < .16$ (Figures 13(d)). $\hat{j}_x$ for winning Democrats in 2006 may reasonably be viewed as similar to $\hat{j}_x$ for winning state house Democrats in 1986 (Figures 8(d)), which would support an interpretation according to which there is no special mobilization.

*** Figure 13 about here ***

Quantitatively, in terms of percentages of voters, the amount by which the actual distributions of voters in the 2004 and 2006 elections deviate from the perfect constancy assumed in the theory of Alesina and Rosenthal (1995, 1996) is probably small. Even though in principle violation of this assumption means the theory does not apply to the midterm, in fact a quantitatively small deviation from the assumption probably also means the amount by which the election outcome deviates from what the theory predicts is small as well. And the deviation that $\hat{j}_x > \bar{j}$ for $\mathfrak{M}_{12} \approx 0$ may be picking up from the theory's midterm predictions for the 2006 midterm, in Figure 11(d), is quantitatively small.

3.3 2008

Mostly I do not discuss the statistics for presidential vote counts, but to fully motivate discussion of the legislative election results in 2008 I do so for that year. The patterns in $\hat{j}_x$

[30] The states for which I have data for 2006 are listed in note 20 on page 9. Not all of those states have elections for the state legislature in 2006. Elections in AZ, NH and VT feature multimember districts. These states are excluded.

for the 2008 presidential election, in Figure 14, clearly reflect voting with asymmetric gains—possibly strategically motivated—in favor of the Democrat. $\hat{j}_x$ persistently has a value of $\hat{j}_x \approx 4.3$ for the Democratic candidate in states where the Democrat won (Figure 14(d)) while for the Republican in those same states (Figure 14(b)) $\hat{j}_x > \bar{j}$ significantly only for an intermediate range of $\mathfrak{M}_{12}$ values. This matches the pattern that based on the first simulation (Table 1) diagnoses strategically switched votes for one candidate—here the Democrat—but based on the second simulation (Figure 1) diagnoses nonstrategic votes for the other.[31] The pattern in $\hat{j}_x$ for the Republican in states where the Republican won (Figure 14(a)) also resemble the simulated nonstrategic pattern in Figure 1(b). $\hat{j}_x$ for the Democrat in states where the Republican won differs significantly from $\bar{j}$ for only a couple of states (Figure 14(c)).

*** Figure 14 about here ***

Whether the asymmetric pattern in Figure 14 reflects solely voters' strategic behavior in accord with the theory of Alesina and Rosenthal (1995) may be doubted, however. The most important reason to believe that voters' strategies alone are not responsible for the apparent surge in votes for winning Democrats is the appearance of gains for winning Democrats in the 2008 elections for the U.S. House. Figure 15, which shows $\hat{j}_x$ for candidates in U.S. House elections that year, suggests that Democratic House winners but not Republican winners seem to benefit from special gains. $\hat{j}_x$ for winning Democrats is significantly greater than $\bar{j}$ except when $.36 < \mathfrak{M}_{12} < .47$, and only when $.3 < \mathfrak{M}_{12} < .5$ is $\hat{j}_x$ significantly less than $\hat{j}_x \approx 4.3$ (Figure 15(d)). $\hat{j}_x$ for winning Republicans differs significantly from $\bar{j}$—$\hat{j}_x > \bar{j}$—only when $.23 < \mathfrak{M}_{12} < .34$ (Figure 15(a)). $\hat{j}_x$ for second-place Republicans and for second-place Democrats resemble $\hat{j}_x$ for second-place candidates in 1984 (compare (Figures 15(b,c)) to Figures 3(b,c)). This asymmetric pattern, which would suggest strategic voting in favor of Democrats both for U.S. House and President, does not match the predictions of Alesina and Rosenthal's theory.

*** Figure 15 about here ***

To rely on mobilization and not primarily strategic behavior to explain the patterns in $\hat{j}_x$ for the presidential and U.S. House elections is not a surprise. For instance, using the Pew Election Weekend surveys (Pew Research Center 2006*a*, 2008) to compare the political views of likely voters between 2008 and the preceding midterm election shows a significantly lower proportion of the likely voters say they are "Moderate" and a significantly higher proportion say they are "Liberal" or "DK/Refused" in 2008 (see Table 13). Comparing the distribution of likely voters in 2008 to the distribution in the previous presidential election, significantly more likely voters say they are "Very Conservative" and significantly fewer say they are "Conservative" in 2008 than in 2004 (Table 13).[32] To assess whether the meaning of the political view categories changed over time, I again use the

[31] The confidence interval for $\hat{j}_x$ in Figure 14(d) includes $\bar{j}$ but also $\hat{j}_x \approx 4.3$ for the two closest states where the Democrat won, namely, IN and FL.

[32] The significance of the differences between 2004 and 2008 refer to the 90% confidence intervals reported in Table 13.

stability of vote intentions as functions of political view categories as the standard for constancy of meaning. Table 14 shows that in a logistic regression of vote intentions on political view category, using data from the 2006 and 2008 Election Weekend surveys, the only significant difference between the elections is that "Moderate" likely voters are more likely in 2006 than in 2008 to support a Democrat instead of a Republican (Table 14). The mobilization of new "Liberal" voters in 2008 seems to help Democratic candidates in ways that the changes in the numbers of "Conservative" and "Very Conservative" voters do not help Republican candidates.

*** Tables 13 and 14 about here ***

The mobilization interpretation of the 2008 elections is also supported by the patterns in state legislative elections. There are signs of special gains by Democratic winners and not by Republicans. $\hat{j}_x$ for Democratic winners in state house elections is virtually always significantly greater than $\bar{j}$, and typically $\hat{j}_x \approx 4.28$ (Figure 16(d)).[33] Occasionally the upper limit of the confidence interval for $\hat{j}_x$ exceeds $\hat{j}_x \approx 4.35$. $\hat{j}_x$ for Republican state house winners is significantly greater than $\bar{j}$ only when $.16 < \mathfrak{M}_{12} < .27$, otherwise $\hat{j}_x$ does not differ significantly from $\bar{j}$ (Figure 16(a)). For second-place Republicans and second-place Democrats, $\hat{j}_x$ in 2008 resembles $\hat{j}_x$ in 2006 (compare Figures 16(b,c) and 12(b,c)). $\hat{j}_x$ for Democratic state senate winners is significantly greater than $\bar{j}$ and near $\hat{j}_x \approx 4.35$ when $.14 < \mathfrak{M}_{12} < .35$ and when $.48 < \mathfrak{M}_{12}$ (Figure 17(d)). For Republican state senate winners $\hat{j}_x$ is significantly greater than $\bar{j}$ only when $.14 < \mathfrak{M}_{12} < .44$ (Figure 17(a)), resembling the nonstrategic pattern of Figure 1(b). Patterns in $\hat{j}_x$ for second-place Republican and for second-place Democratic state senate candidates resemble the patterns for second-place state senate candidates in other years (Figures 17(b,c)).

*** Figures 16 and 17 about here ***

3.4 2010

In view of the previously discussed large gains by Republicans in 2010, we might intuitively think that any mobilization story for that year involves mobilization in favor of the Republicans. Perhaps the energy manifested by the "TEA Party" is the locus for that. On the other hand, the election returns and even the "TEA Party" activism may be nothing more than a somewhat large manifestation of the usual midterm movement of the electorate's policy positions away from the president's party (Mebane and Sekhon 2002). One aspect of this is whether the distribution of policy preferences satisfies the condition necessary for the model of Alesina and Rosenthal (1996) to apply: is the proportion of the electorate with policy preferences located between the policy positions of the two parties constant between the presidential election of 2008 and the midterm of 2010. The discussion of Pew data referring to Table 9 addressed this, but that analysis had the major weakness that only the positions of the likely voters were explicitly measured. Some volatility is

[33] In Figure 16(d), $\hat{j}_x$ does not differ significantly from $\bar{j}$ only when $\mathfrak{M}_{12} < .01$.

apparent in those positions, but the volatility is mainly on the "Very Conservative" extreme and any relationship to the positions of the parties is conjectural.[34]

The patterns in $\hat{j}_x$ for for Democratic candidates in U.S. House elections in 2010, in Figures 18(c,d), resemble the patterns in $\hat{j}_x$ for Democratic candidates in U.S. House elections in 2008. For Democratic winners (Figure 18(d)), $\hat{j}_x > \bar{j}$ significantly for all values of $\mathfrak{M}_{12}$, and $\hat{j}_x$ is usually not significantly different from $\hat{j}_x \approx 4.35$.[35] For second-place Democratic candidates (Figure 18(c)) $\hat{j}_x$ resembles the pattern in the nonstrategic, two-party simulation (Figure 1(b)). The digit patterns for these candidates in the midterm give evidence of special mobilization for the winners to the same extent as do the patterns in the preceding presidential election.

*** Figure 18 about here ***

For Republican candidates in the 2010 U.S. House elections, $\hat{j}_x$ does not suggest any kind of special mobilization for these candidates. The pattern for Republican winners (Figure 18(a)) has the familiar form that matches the nonstrategic pattern of Figure 1(b). The pattern for second-place Republicans (Figure 18(b)) is similar to the pattern for second-place Democrats in 2006 (compare Figure 11(c)).

In the state House elections of 2010, for both parties the patterns in $\hat{j}_x$ closely resemble the patterns observed in the 2006 and 2008 elections more than they do the patterns from the midterms of the 1980s. The difference, as in 2006, is mainly apparent for $\hat{j}_x$ for winning Democrats. $\hat{j}_x$ for winning Democrats in the state House elections (Figure 19(d)) is usually greater than $\bar{j}$ and often not significantly different from $\hat{j}_x \approx 4.35$. For winning Republicans (Figure 19(a)) $\hat{j}_x$ once again resembles the simulated pattern of Figure 1(b) and for second-place Republicans and Democrats (Figures 19(b,c)) $\hat{j}_x$ again resembles the simulated pattern of Figure 2(a). Signs of special mobilization are apparent for Democratic winners but not for the other classes of candidates.

*** Figures 19 about here ***

In the state Senate elections of 2010 there is no clear evidence of mobilization for either party. The confidence bounds for $\hat{j}_x$ for Democratic winners are wide (Figure 20(d)); while the point estimate of $\hat{j}_x$ is always greater than $\bar{j}$, $\hat{j}_x > \bar{j}$ significantly only for a an intermediate range of $\mathfrak{M}_{12}$ values. So the dominant impression is that more than anything else the pattern resembles the simulated pattern summarized in Figure 1(b). The patterns in $\hat{j}_x$ for the other classes of candidates have the familiar forms that do not suggest any strategically motivated or any other special mobilization.

*** Figure 20 about here ***

[34] The Cooperative Congressional Election Study (CCES) (Ansolabehere 2006, 2011, 2010) has asked respondents to place themselves and other political entities (importantly, including the major parties) on ideological scales since 2006. Using these data to find the proportion of respondents who place themselves between the major parties in each cycle should be a straightforward exercise. Unfortunately, as discussed in Mebane and Kent (2013), the measurement of ideological placement changed between the 2008 and 2010 CCES. The differing formats of the raw data do not support any clear conclusion about whether the condition necessary for the theory of Alesina and Rosenthal (1996) to apply is satisfied.

[35] The upper bound of the confidence interval for $\hat{j}_x$ is less than 4.35 when $.14 < \mathfrak{M}_{12} < .6$, and for those values of $\mathfrak{M}_{12}$ $\hat{j}_x$ is never significantly less than $\hat{j}_x \approx 4.28$.

3.5 Discussion

The statistics based on the second significant digits of precinct vote counts suggest that from the 1980s to the late 2000s there has been a substantial change in the way not only midterm but indeed all American legislative elections operate. The changes affect not only national elections but also the degree to which state elections are entangled with federal elections.

At the federal level, in the 2000s U.S. House races do not present a significantly different pattern at midterm than they do in presidential election years. In the 1980s, for Democratic winners the pattern in the conditional second-digit mean ($\hat{j}_x$) suggests these candidates were benefiting from strategically motivated votes in ways the same kinds of candidates did not benefit at midterm. Strictly speaking, the conditional second-digit means do not speak to the motivations for any gains they are indicating occur, but they testify only to their occurrence. The strategic interpretation for the pattern comes mainly from the background theoretical and empirical findings that support the Alesina and Rosenthal (1995, 1996) theory about strategic partisan balancing and coordination. That theory's predictions happen to match closely the patterns observed during the 1980s: winning federal legislative candidates of the party opposing the president gain votes in the presidential year but not at midterm; winning candidates of the same party as the president show no special gains. In the elections of 2006 and 2010, winning Democrats show signs of special gains but there is no support for such gains from the theory of Alesina and Rosenthal (1995, 1996). Indeed, in the presidential election of 2008, winning Democratic U.S. House candidates seem to gain according to the digit diagnostics even as the Democratic presidential candidate was expected to win and did in fact win. Such a result seems to be a complete overthrow of the theory.

Whether the Alesina and Rosenthal (1996) mechanism no longer operates remains a question, but I suggest that in any case new forms of mobilization have come into play—at least on the Democratic side—that perhaps outweigh it (e.g. Issenberg 2012).[36] The movements in votes due to the new forms of mobilization may simply be larger than the movements in votes due to the Alesina and Rosenthal (1995, 1996) mechanism, and statistics such as the conditional mean of the second-digits reflect only the net effect of all such forces.

A substantial difference in mobilization between the 1980s and the 2000s may also explain why, in terms of the conditional second-digit means, state legislative elections track the federal elections in the later period in ways that do not occur in the earlier period. Extensive support for this is outside the scope of this paper, but a cursory investigation bolsters it somewhat: the Democratic Legislative Campaign Committee, for example, was founded in 1994 to professionalize Democratic state legislative elections (Democratic Legislative Campaign Committee 2013); since 2004, the organization's 527 arm has spent roughly $50 million toward this end (OpenSecrets.org 2013). In view of these developments, it is not surprising that state legislative elections have begun to track federal election mobilization phenomena more closely.

[36] There is reason to believe that this revolution in mobilization is indeed one-sided in the time period I study here. As one Romney campaign operative put it, "[Democrats] were playing chess while we were playing checkers"—even through 2012 (Draper 2013).

4 Germany

In the German case, consider displays based on *Erststimmen* and *Zweitstimmen* recorded in the Bundestag elections of 2002, 2005 and 2009. Each voter in these elections casts two votes. *Erststimmen* (first votes) determine the winner of each *Wahlkreis* (district) through a plurality voting rule, and *Zweitstimmen* (second votes) determine the overall share of the seats each party has in the Bundestag through proportional representation (PR) rules.[37] In Figure 21(a), the x-axis shows the margin between the first-place and second-place candidates in each *Wahlkreis* as a proportion of the valid ballots cast in the *Wahlkreis*, and the y-axis shows the difference between the number of *Zweitstimmen* and *Erststimmen* received in each *Wahlkreis* by SPD as a proportion of all ballots cast in the *Wahlkreis*.[38] I use $\mathfrak{M}_{12}$ to refer to the x-axis quantity and $\mathfrak{D}_{\text{SPD}}$ to refer to the y-axis quantity. Previous work has used the difference between a party's *Erststimmen* and *Zweitstimmen* as an indicator of the number of strategically switched votes the party was receiving in its *Erststimmen* total (e.g. Cox 1997, 83; Bawn 1999). Shifts that are larger in absolute magnitude arguably indicate higher proportions of voters engaging in strategic vote switching, whether through "wasted vote" reasoning or "threshold insurance" calculations (Herrmann and Pappi 2008; Shikano, Herrmann and Thurner 2009).

*** Figure 21 about here ***

The curved lines plotted in Figure 21(a) show contours of $\hat{j}$ estimated using polling station vote counts' second digits—pooling data from all three elections—in a two-dimensional nonparametric regression (Bowman and Azzalini 1997, 2003) with $\mathfrak{M}_{12}$ and $\mathfrak{D}_{\text{SPD}}$ as regressors.[39] The numbers shown in the figure along the lines report the values of $\hat{j}$ along the referent contours. Use $\hat{j}_{xy}$ to denote this conditional mean. Figure 21(a) is based on the digits of the SPD's vote counts from every *Wahlkreis* where SPD was the second-place party. Blank areas in the figure (such as the lower right corner) reflect combinations of $\mathfrak{M}_{12}$ and $\mathfrak{D}_{\text{SPD}}$ values that do not occur in the data. Standard errors are not depicted in the figure, but a test of the two-dimensional regression model against a model in which both regressors have "no effect" shows that $\hat{j}$ does vary significantly as a function of the two covariates.[40]

The second-digit means often are not those 2BL would imply. As $\mathfrak{M}_{12}$ increases, $\hat{j}_{xy}$ tends to decrease, from $\hat{j}_{xy} \approx 4.4$ for $\mathfrak{M}_{12} \approx 0$ down to $\hat{j}_{xy} \approx 3.85$ for $\mathfrak{M}_{12} \approx .5$. Values of $\hat{j}_{xy} \approx \bar{j}$ occur only for $\mathfrak{M}_{12} \approx .2$. $\hat{j}_{xy}$ also responds slightly to $\mathfrak{D}_{\text{SPD}}$, particularly for negative values of $\mathfrak{D}_{\text{SPD}}$.

Figure 21(b) plots the contours from a similar two-dimensional nonparametric regression based on the digits of the SPD's vote counts from every *Wahlkreis* where SPD

[37] To receive seats through the PR process, a party must receive more than five percent of the valid *Zweitstimmen* "in the electoral area" or win three *Wahlkreise* based on *Erststimmen*. PR outcomes as determined by the *Zweitstimmen* depend on the *Erststimmen* in other ways too complicated to explain here (Bundeswahlleiter 2011*a*, Section 6).

[38] SPD is the Social Democratic Party.

[39] Two-dimensional nonparametric regressions are computed using the `sm` package of **R** (R Development Core Team 2011). The `sm.regression()` function call uses `method=aicc`.

[40] The `sm.regression()` function call also includes the argument `model='no effect'` and reports "Test of no effect model: significance = 0," indicating a very small significance level.

was the first-place party. Now $\hat{j}_{xy}$ varies significantly with $\mathfrak{D}_{\rm SPD}$, increasing from $\hat{j}_{xy} \approx 4.3$ for $\mathfrak{D}_{\rm SPD} \approx 0$ to $\hat{j}_{xy} \approx 4.55$ for $\mathfrak{D}_{\rm SPD} \approx -.12$ and $\mathfrak{M}_{12} \approx .3$. $\hat{j}_{xy}$ also responds to $\mathfrak{M}_{12}$. $\hat{j}_{xy} \approx 4.35$ for $\mathfrak{M}_{12} \approx 0$ and $\mathfrak{D}_{\rm SPD} \approx -.04$ and also for $\mathfrak{M}_{12} \approx .29$ and $\mathfrak{D}_{\rm SPD} \approx 0$. Nowhere in the figure is $\hat{j}_{xy}$ near $\bar{j}$.[41]

Consider the pattern for the German Bundestag elections of 2002, 2005 and 2009, in Figure 21(a), for the second digits of polling station counts of votes cast for the SPD in *Wahlkreise* where the SPD is the party that received the second highest number of votes in the *Wahlkreis*. The variations in the digits can be explained by district imbalance, with rolloff, and strategic voting: the pattern of $\hat{j}_{xy}$ values in the figure match the patterns observed in the simulations.

To see the district imbalance point, compare $\hat{j}_{xy}$ as it varies with $\mathfrak{M}_{12}$ in Figure 21(a), for $\mathfrak{D}_{\rm SPD}$ values near zero, to the line ($\hat{j}_x$) that shows the pattern of digits for the first (disadvantaged) candidate as "2d candidate advantage" (κ) increases in Figure 2(a). κ determines the margin expected between the first- and second-place candidates[42] and so is comparable to $\mathfrak{M}_{12}$ shown in Figure 21(a), although of course the simulation includes exactly two candidates while in the German elections there are many more than two parties with candidates in each *Wahlkreis*. In Figure 21(a) there are no data with $\mathfrak{D}_{\rm SPD} = 0$ for $\mathfrak{M}_{12}$ less than about .04, so the parts of Figure 2(a) corresponding to the very lowest values of κ lack matches in Figure 21(a). But the curve for the disadvantaged candidate in Figure 2(a) has a pattern of $\hat{j}_x$ values declining as κ increases just as Figure 21(a) has $\hat{j}_{xy}$ declining as $\mathfrak{M}_{12}$ increases. The values of $\hat{j}_x$ are very close to the values of $\hat{j}_{xy}$ for corresponding values of κ and $\mathfrak{M}_{12}$. For instance, $\hat{j}_{xy} \approx 3.95$ and $\hat{j}_x \approx 4.05$ when $\kappa = \mathfrak{M}_{12} = .4$, $\hat{j}_{xy} \approx 4.15$ and $\hat{j}_x \approx 4.17$ when $\kappa = \mathfrak{M}_{12} = .2$ and $\hat{j}_{xy} \approx 4.25$ and $\hat{j}_x \approx 4.2$ when $\kappa = \mathfrak{M}_{12} = .1$. The qualitative correspondence is remarkable. In Figure 1(b) the curve for the disadvantaged candidate with turnout decline also has a pattern of $\hat{j}_x$ values declining as κ increases that matches $\hat{j}_{xy}$ in Figure 21(a).[43] Looking at the values of $\hat{j}_{xy}$ only where $\mathfrak{D}_{\rm SPD} \approx 0$ is reasonable because the simulations that produce Figures 1 and 2(a) include no strategic voting, so if $\mathfrak{D}_{\rm SPD}$ does roughly correspond to the amount of strategically switched votes, using places where $\mathfrak{D}_{\rm SPD} \approx 0$ constrains the empirical analysis to places where strategic switching is minimal.

The correspondence between the simulation and what actually happens in German elections is not unique to SPD. Figure 21(c) shows $\hat{j}_{xy}$ estimated for the second digits of polling station counts of votes cast for CDU/CSU in *Wahlkreise* where CDU/CSU is the party that received the second greatest number of votes in the *Wahlkreis*.[44] Now the y-axis is defined in terms of *Erststimmen* and *Zweitstimmen* for CDU/CSU, and the measure is denoted by $\mathfrak{D}_{\rm CDU}$. As in Figure 21(a), $\hat{j}_{xy}$ declines as $\mathfrak{M}_{12}$ increases. The values of $\hat{j}_{xy}$ for $\mathfrak{D}_{\rm CDU} \approx 0$ in Figure 21(c) are similar to those in Figure 21(a). To the extent partisan imbalances among voters are the reason for the margins in these *Wahlkreise*, the

[41] `sm.regression()` reports "Test of no effect model: significance = 0" for these contours, so it's reasonable to conclude that the differences of $\hat{j}_{xy}$ from $\bar{j}$ are significant.

[42] κ does not equal the margin between the two candidates but it is monotonically related to the margin.

[43] The values of $\hat{j}_x$ tend to be greater than values of $\hat{j}_{xy}$ for corresponding values of κ and $\mathfrak{M}_{12}$. For instance, $\hat{j}_{xy} \approx 3.95$ and $\hat{j}_x \approx 4.05$ when $\kappa = \mathfrak{M}_{12} = .4$, $\hat{j}_{xy} \approx 4.15$ and $\hat{j}_x \approx 4.3$ when $\kappa = \mathfrak{M}_{12} = .2$ and $\hat{j}_{xy} \approx 4.25$ and $\hat{j}_x$ is slightly greater than 4.3 when $\kappa = \mathfrak{M}_{12} = .1$.

[44] CDU/CSU is the Christian Democratic Union/Christian Social Union.

simulations suggest that those district imbalances considerably explain these patterns in the second digits of the vote counts.

The relevance of Figure 1(b) to these German election data partly depends on there being a pattern of decline in turnout with increasing election margins in the German elections. Stiefbold (1965) writes that the invalid vote in Germany "expresses a variety of political discontent" (Stiefbold 1965, 392), but the concept of turnout that relates to the simulation must encompass those eligible voters who do not cast votes at all. In 2005 and 2009 turnout as measured by Bundeswahlleiter (2012*b*,*a*) generally declines as $\mathfrak{M}_{12}$ increases. The patterns of decline qualitatively validate the second simulation,[45] even if the implementation of "rolloff" in Mebane (2012, eq. (6)) may not be a correct model in quantitative detail for Germany.

The simulations seem to match the real election data when $\mathfrak{D}_{\text{SPD}} \approx 0$ and $\mathfrak{D}_{\text{CDU}} \approx 0$, but what happens with larger magnitudes of $\mathfrak{D}_{\text{SPD}}$ and $\mathfrak{D}_{\text{CDU}}$—when the $\mathfrak{D}_k$ measures suggest there is a subtantial amount of strategic vote switching? I return to this question in relation to the *Wahlkreise* where SPD or CDU/CSU finished second in a moment, but first it is convenient to consider those places where SPD won. These are the *Wahlkreise* for which $\hat{j}_{xy}$ values are estimated in Figure 21(b).

The immediate thing to notice in Figure 21(b) is that the value of $\hat{j}_{xy}$ increases as $\mathfrak{D}_{\text{SPD}}$ becomes more negative. For $\mathfrak{M}_{12} \approx 0$, we have $\hat{j}_{xy} = 4.3$ for $\mathfrak{D}_{\text{SPD}}$ just above zero, $\hat{j}_{xy} = 4.35$ for $\mathfrak{D}_{\text{SPD}} \approx -.04$ and $\hat{j}_{xy} = 4.4$ for $\mathfrak{D}_{\text{SPD}} \approx -.1$. The $\hat{j}_{xy}$ values rise to match the $\hat{j}$ values observed in the first simulation when a party receives strategically switched votes. Indeed, $\hat{j}_{xy} = 4.4$ is larger than the value of $\hat{j} = 4.35$ that occurred with strategic switching in that asymmetric case, as reported in Table 1. The smallest value for $\hat{j}_{xy}$ in Figure 21(b), $\hat{j}_{xy} = 4.3$, matches the value reported in Table 1 for the digits in the sincere vote counts (y_1) for the party that has an ideologically similar party competing against it in the same district.[46] Higher values of $\hat{j}_{xy}$ occur for more negative values of $\mathfrak{D}_{\text{SPD}}$ and as $\mathfrak{M}_{12}$ rises. The highest value of $\hat{j}_{xy}$, namely, $\hat{j}_{xy} = 4.55$, occurs in the figure for $\mathfrak{D}_{\text{SPD}} \approx -.12$ and $\mathfrak{M}_{12} \approx .3$. Values of $\hat{j}$ this large do not occur in the first simulation, but that simulation also does not produce $\mathfrak{M}_{12}$ as large as occurs in Figure 21(b).

The value of $\hat{j}_{xy}$ seems strongly related to the amount of strategic vote switching, but thinking about the "wasted vote logic" that is likely the reason for the vote switching (Herrmann and Pappi 2008) suggests that the margin variable being used in the analysis is not the most appropriate one. The key quantity in such strategic voting is not the difference between the top two finishers but rather the differences between each of those parties and the party that comes in third. With "Duvergerian" equilibria (Cox 1994) in single-member districts, two parties get almost all the votes and votes for all other parties are reduced to negligible amounts. So margins defined relative to the third-place finisher are arguably more indicative of strategic activity than the margin between the top two finishers, even if the top-two margin may be most relevant when thinking about turnout declines caused by district imbalance.[47]

[45] Likewise they validate the third simulation with $b_1 = b_2 = -2$.

[46] The *Wahlkreise* that have $\hat{j}_{xy} = 4.3$ in the pooled 2002, 2005 and 2009 data are in the eastern German *Länder* Mecklenburg-Vorpommern, Saxony-Anhalt and Thuringia.

[47] The 0-1 hypothesis introduced by Cox (1994) would involve the margin between the second- and third-place candidates.

Figure 22(a) shows $\hat{j}_{xy}$ estimates using SPD vote counts from *Wahlkreise* where SPD was the first-place party, as in Figure 21(b), except using $\mathfrak{M}_{13}$, the margin between the first- and third-place parties in each *Wahlkreis*. The contours in Figure 22(a) are somewhat more horizontal than in Figure 21(b), so that $\hat{j}_{xy}$ varies more with $\mathfrak{D}_{\text{SPD}}$ than it does with $\mathfrak{M}_{13}$. The minimum value of $\hat{j}_{xy}$ is the 4.28 for $\mathfrak{D}_{\text{SPD}} \approx .035$, very similar to the minimum value with $\mathfrak{M}_{12}$. $\hat{j}_{xy}$ now has a maximum of $\hat{j}_{xy} = 4.46$, less than in Figure 21(b). The maximum of $\hat{j}_{xy}$ in Figure 22(a) corresponds to the most negative value of $\mathfrak{D}_{\text{SPD}}$, however, so $\hat{j}_{xy}$ might be said more strictly to increase with the amount of strategic vote switching.

*** Figure 22 about here ***

Using $\mathfrak{M}_{23}$, the margin between the second- and third-place parties, to estimate $\hat{j}_{xy}$ for SPD votes in *Wahlkreise* where SPD is the second-place party produces the contours shown in Figure 22(b). Compared to Figure 21(a), which I interpreted in terms of district imbalance, the $\hat{j}_{xy}$ contours in Figure 22(b) are more horizontal, at least for $\mathfrak{D}_{\text{SPD}} < 0$, and for $\mathfrak{D}_{\text{SPD}} < 0$ $\hat{j}_{xy}$ increases as $\mathfrak{D}_{\text{SPD}}$ decreases and $\mathfrak{M}_{23}$ increases. The maximum value, now $\hat{j}_{xy} = 4.5$, occurs when both $\mathfrak{D}_{\text{SPD}} \approx -.125$, near the most negative value, and $\mathfrak{M}_{23}$ is near its maximum value.[48] When $\mathfrak{D}_{\text{SPD}} < 0$ indicates that many strategically switched votes are being added to the SPD's totals, so do the second digits of the votes through $\hat{j}_{xy}$.

When $\mathfrak{D}_{\text{SPD}} > 0$, presumably strategically switched votes are being subtracted from the SPD's *Erststimmen* totals. $\hat{j}_{xy}$ tends to get smaller as $\mathfrak{D}_{\text{SPD}}$ increases above zero. The minimum value $\hat{j}_{xy} = 3.9$ occurs for the most positive value $\mathfrak{D}_{\text{SPD}} \approx .15$. The five most positive values of $\mathfrak{D}_{\text{SPD}}$ in Figure 22(b)—all the values where $\mathfrak{D}_{\text{SPD}} > .05$—occur in Berlin in *Wahlkreise* where Die Linke won in 2009. The $\mathfrak{D}_{\text{SPD}}$ values therefore suggest some voters who sincerely prefer SPD are switching strategically to vote for Die Linke in those *Wahlkreise*. This scenario where a large party is strategically abandoned by a substantial but still small proportion of voters is not represented in the simulations, although numerically the values of $\hat{j}_{xy}$ are close to the values of $\hat{j}_x$ for the disadvantaged candidate in the third simulation where there is both strategic voting and turnout decline due to district imbalance (see Figure 2(b)). It seems that the limited strategic abandonment, which $\mathfrak{D}_{\text{SPD}} > 0$ indicates is occurring even though the vote for SPD is not being reduced to negligible amounts, has an effect on the vote counts' second digits similar to the effect turnout decline has on vote counts' digits in the simulation.[49]

Using $\mathfrak{D}_{\text{CDU}}$ and $\mathfrak{M}_{23}$ with the second digits of votes cast for CDU/CSU in *Wahlkreise* where CDU/CSU is the second-place party produces nearly vertical contours in $\hat{j}_{xy}$. See Figure 22(c). Since the contours of $\hat{j}_{xy}$ are not perfectly vertical, $\mathfrak{D}_{\text{SPD}}$ affects $\hat{j}_{xy}$ to some extent. So strategic vote switching that adds to the votes for CDU/CSU in places where CDU/CSU finished second does affect $\hat{j}_{xy}$ when the amount of vote switching is large enough. $\hat{j}_{xy}$ reaches 4.35 only for $\mathfrak{M}_{23}$ greater than about .22. As was true for SPD, *Wahlkreise* that have large $\mathfrak{M}_{23}$ in Figure 22(c) have $\mathfrak{M}_{12} \approx 0$ in Figure 21(c).

[48]Interestingly, the *Wahlkreise* that have large $\mathfrak{M}_{23}$ in Figure 22(b) have $\mathfrak{M}_{12} \approx 0$ in Figure 21(a).

[49]Analysis of the digits in vote counts for PDS/Linke (Party of Democratic Socialism/The Left), not reported here, shows $\hat{j}_{xy} \approx 4.5$ for the second digits in votes for Die Linke in 2009 in these same Berlin *Wahlkreise*, which indicates that party was receiving strategically switched votes. To understand the strategies involved here, one might invoke the concept of "activist valence" (Schofield and Sened 2006), mentioning Oskar Lafontaine as a key activist (e.g. Connolly 2010).

The $\hat{j}_{xy}$ contours when $\hat{j}_{xy}$ is estimated using $\mathfrak{M}_{13}$ and the digits of the CDU/CSU vote counts from *Wahlkreise* where CDU/CSU is the first-place party—Figure 22(d)—are similar to those observed in Figure 22(a) when SPD is the first-place party. Looking from left to right, the contours start off horizontal, meaning the $\hat{j}_{xy}$ is solely a function of $\mathfrak{D}_{\text{CDU}}$, then they tilt upward slightly, indicating that $\mathfrak{M}_{13}$ also affects $\hat{j}_{xy}$. As was the case in Figure 22(a), the maximum $\hat{j}_{xy} = 4.5$ in Figure 22(d) corresponds to the most negative value of $\mathfrak{D}_{\text{CDU}}$, so $\hat{j}_{xy}$ is higher when the amount of strategic vote switching to CDU/CSU is higher. Very positive values of $\mathfrak{D}_{\text{CDU}}$ do not occur.

The simulated digit patterns match the patterns in German Bundestag elections that are expected according to theories and previous empirical findings regarding the kinds of strategies voters are using in those elections. The upper bound on the second-digit means, $\hat{j}_{xy}$, observed in the real election data exceeds the upper bound in the simulation, but this seems due to the German data having local party imbalances—“district imbalances”—more extreme than were considered in the simulation.

4.1 Coalition Threshold Insurance: FDP versus Greens

Simple strategic voting according to wasted-vote logic in Germany involves a pattern in which some voters cast *Zweitstimmen* sincerely for a small party while casting their *Erststimmen* for a larger party, typically CDU/CSU or SPD. Coalition threshold insurance arises when some supporters of the larger parties cast their *Zweitstimmen* for one of the smaller parties—FDP or Greens—in order to support that party’s involvement in a coalition in the Bundestag. Evidence using survey-based preference measures exists to suggest both kinds of strategy occur in the 1998 (Pappi and Thurner 2002; Gschwend 2007) and 1994 (Shikano, Herrmann and Thurner 2009) elections.

Conditional digit means $\hat{j}_{xy}$—with covariates given by, for example, margin variables like $\mathfrak{M}_{13}$ and *Zweitstimmen-Erststimmen* differences like $\mathfrak{D}_{\text{SPD}}$—also suggest that a complex of strategic actions affect votes received by the two small parties. One way to show this is to use measures $\mathfrak{D}_k$ that measure the difference between the number of *Zweitstimmen* and *Erststimmen* received in each *Wahlkreis* by party k as a proportion of all ballots cast in the *Wahlkreis*. These quantities are associated with the number of strategically switched votes (e.g. Cox 1997, 83; Bawn 1999), although in the current case we acknowledge that possibly both *Erststimmen* and *Zweitstimmen* totals contain strategically switched votes.

Scatterplots of $\mathfrak{D}_k$ for the small parties against $\mathfrak{D}_k$ for the larger parties offer some evidence about when votes are being changed in line with strategic calculations. Comparing Figures 23(a) and 23(b), which use use data from 1994 and 1998 to plot $\mathfrak{D}_{\text{SPD}}$ against respectively $\mathfrak{D}_{\text{FDP}}$ and $\mathfrak{D}_{\text{Greens}}$, $\mathfrak{D}_{\text{SPD}}$ is clearly more strongly associated with $\mathfrak{D}_{\text{Greens}}$ than with $\mathfrak{D}_{\text{FDP}}$. Because SPD and Greens were plausible coalition partners in 1994 and 1998 while SPD and FDP were not (Pappi and Thurner 2002), such a difference in the associations makes sense: in *Wahlkreise* where $\mathfrak{D}_{\text{SPD}}$ indicates that votes are being switched strategically from *Erststimmen* to *Zweitstimmen* with respect to SPD, $\mathfrak{D}_{\text{Greens}}$ tends to show that votes are being switched from *Zweitstimmen* to *Erststimmen*, and vice versa. Likewise comparing Figures 23(c) and 23(d), which plot $\mathfrak{D}_{\text{CDU}}$ against $\mathfrak{D}_{\text{FDP}}$ and $\mathfrak{D}_{\text{Greens}}$ for the same years, shows $\mathfrak{D}_{\text{CDU}}$ more strongly associated with $\mathfrak{D}_{\text{FDP}}$. In 1994 and

1998 CDU/CSU and FDP were likely coalition partners (Pappi and Thurner 2002).

*** Figure 23 about here ***

References to "vice versa" bring out the heterogeneity of strategies evident in various *Wahlkreise*. When $\mathfrak{D}_{\text{Greens}} < 0$ and $\mathfrak{D}_{\text{SPD}} > 0$, the direct interpretation is that some of the major party supporters cast *Erststimmen* strategically for the Greens candidate but *Zweitstimmen* for SPD. Some care is needed. The value $(\mathfrak{D}_{\text{Greens}}, \mathfrak{D}_{\text{SPD}}) \approx (-.14, .34)$ in Figure 23(b) is from a *Wahlkreis* where no SPD candidate was running in the *Wahlkreis*,[50] but 44 other *Wahlkreise* also have $\mathfrak{D}_{\text{Greens}} < 0$ and $\mathfrak{D}_{\text{SPD}} > 0$.[51] Fewer *Wahlkreise* have $\mathfrak{D}_{\text{FDP}} < 0$ and $\mathfrak{D}_{\text{CDU}} > 0$—four do—but the *Wahlkreis* where $(\mathfrak{D}_{\text{FDP}}, \mathfrak{D}_{\text{CDU}}) \approx (-.09, .23)$, in Figure 23(c), corresponds to a *Wahlkreis* where no CDU/CSU candidate was running in the *Wahlkreis*.[52] Perhaps the two cases where there was no candidate running for a major party should not be included as examples of "strategic" behavior on the part of voters who support those parties, but the prima facie interpretation holds for the other instances, in all of which major party candidates did receive *Erststimmen*.

When $\mathfrak{D}_{\text{Greens}} > 0$ and $\mathfrak{D}_{\text{SPD}} < 0$ in Figure 23(b) and when $\mathfrak{D}_{\text{FDP}} > 0$ and $\mathfrak{D}_{\text{CDU}} < 0$ in Figure 23(c), there is prima facie evidence that voters who sincerely favor the minor party are switching their *Erststimmen* to the major party in accord with wasted vote logic. Of course these patterns also include major party voters who switch to support the minor party in their *Zweitstimmen*, so these *Wahlkreise* also include places where there was extensive coalition insurance behavior. There are 213 (283) such *Wahlkreise* with $\mathfrak{D}_{\text{Greens}} > 0$ and $\mathfrak{D}_{\text{SPD}} < 0$ in 1994 (1998), and there are 298 (309) such *Wahlkreise* with $\mathfrak{D}_{\text{FDP}} > 0$ and $\mathfrak{D}_{\text{CDU}} < 0$ in 1994 (1998). The patterns are nearly ubiquitous for the FDP and almost as prevalent for Greens in 1998, the election after which they first entered a federal coalition government with the SPD. In light of the post-election coalition after 1998, the increase in apparent coalition-aware voting behavior from 1994 to 1998 is notable. The relationship between Greens and SPD does not quite mirror the relationship between the FDP and CDU/CSU. If nothing else, the latter parties had a long history of forming elite-driven federal coalitions with one another, while the 1998 SPD-Greens coalition was for Germany "the first coalition ever to have resulted unambiguously from the wishes of the voters" (Richter 2002, 1).

The conditional second-digit means, $\hat{j}_{xy}$, of the *Zweitstimmen* polling station vote counts using $\mathfrak{D}_k$ covariates testify to a clear distinction between the parties. In Figure 24(b), $\hat{j}_{xy} \approx 4.25$ near $\mathfrak{D}_{\text{Greens}} = \mathfrak{D}_{\text{SPD}} = 0$, where the $\mathfrak{D}_k$ statistics suggest little strategic vote switching is occurring. This value is similar to the value of $\hat{j}_x$ in Table 1 for the cases where a party has a preferentially similar competitor. The value $\hat{j}_x = 4.29$ for y_1 in Table 1,

[50]The *Wahlkreis* is number 309, Leipzig I, Saxony, in 1994.

[51]Even though there was a federal SPD-Greens coalition government after 1998 but not 1994, there are more such *Wahlkreise* in the 1994 election than in the 1998 election. Of the 45 *Wahlkreise* in Figure 23 with $\mathfrak{D}_{\text{Greens}} < 0$ and $\mathfrak{D}_{\text{SPD}} > 0$, 33 are from the 1994 election. In 1994, eleven such *Wahlkreis* are in Bavaria, six in Saxony and three in Mecklenburg-Vorpommern. In 1998, six such *Wahlkreise* are in Bavaria, four in Baden-Württemberg and none in Saxony or Mecklenburg-Vorpommern. Of course, it may be that the likelier prospect of a coalition government after 1998 than after 1994 reduced incentives to cast Greens *Erstimmen* in 1998.

[52]The *Wahlkreis* is number 277, Fürstenwalde-Strausberg-Seelow, Brandenburg, in 1998.

for instance, is not significantly different from 4.25.[53] As $\mathfrak{D}_{\text{SPD}}$ falls and $\mathfrak{D}_{\text{Greens}}$ increases, $\hat{j}_{xy}$ decreases down to values near $\hat{j}_{xy} \approx 4.0$. The values are like those observed for strategic votes received by the disadvantaged party in the third simulation in Mebane (2012). Recall Figure 2(b). On the other hand, near $\mathfrak{D}_{\text{FDP}} = \mathfrak{D}_{\text{CDU}} = 0$, in Figure 24(c), $\hat{j}_{xy} \approx 4.0$, and as $\mathfrak{D}_{\text{CDU}}$ decreases and $\mathfrak{D}_{\text{FDP}}$ increases, $\hat{j}_{xy}$ increase to $\hat{j}_{xy} \approx 4.25$. Such a pattern somewhat resembles patterns previously seen in which $\hat{j}_{xy}$ increases as the amount of strategic vote switching increases (e.g., Figures 22(c) and 22(d)), although the values of $\hat{j}_{xy}$ are lower in Figure 24(c).

*** Figure 24 about here ***

To understand the difference between Figures 24(b), where $\hat{j}_{xy}$ apparently decreases with increasing amounts of strategic vote switching, and 24(c), where it seems $\hat{j}_{xy}$ increases with increasing amounts of strategic vote switching, it is useful to recall a result from Pappi and Thurner (2002). Pappi and Thurner (2002, 221, Table 2) show survey data drawn immediately before the 1998 election that imply that the effective number of parties supporting the CDU-FDP coalition was 1.12 while the number supporting the SPD-Greens coalition was 1.24.[54] The SPD-Greens coalition in this sense had more widely dispersed electoral support than the CDU-FDP coalition did. Moreover the SPD-Greens coalition was supported heavily by SPD, Greens and PDS supporters, while the CDU-FDP coalition was supported almost exclusively by CDU/CSU and FDP supporters. So it's likely *Zweitstimmen* for Greens came from voters whose party preference was for SPD, Greens or PDS while *Zweitstimmen* for FDP came overwhelmingly from voters whose party preference was for either CDU/CSU or FDP. The SPD-Greens coalition therefore had more heterogeneous policy or ideological foundations than the CDU-FDP coalition did. A more diverse basis of support for Greens *Zweitstimmen* is more akin to the symmetric simulation of Figure 2(b) while the more concentrated basis of support for FDP—strategically switched votes come by and large only from those who prefer CDU/CSU—more resembles the asymmetric simulation summarized in Table 1. $\hat{j}$ tends to decrease with more strategic voting in the former case, but under the latter circumstance it tends to increase with more strategic voting.

The pattern in Figure 24(a) shows a pattern resembling that in Figure 24(c), where $\hat{j}_{xy}$ increases as $\mathfrak{D}_{\text{FDP}}$ increases, and Figure 24(d) shows a pattern resembling the one in Figure 24(b), where $\hat{j}_{xy}$ decreases as $\mathfrak{D}_{\text{Greens}}$ increases, but since the $\hat{j}_{xy}$ values in Figures 24(a) and 24(d) do not represent conditioning with respect to likely federal coalition partners—the covariates are respectively $(\mathfrak{D}_{\text{CDU}}, \mathfrak{D}_{\text{FDP}})$ and $(\mathfrak{D}_{\text{SPD}}, \mathfrak{D}_{\text{Greens}})$—these two

[53] Of course for y_3 in Table 1 $\hat{j}_x = 4.35 \pm .082$, an interval that just excludes the value 4.25. It's not clear whether y_1 or y_3 is the better match to the *Zweitstimmen* for FDP. The proportional representation electoral rules that govern the *Zweitstimmen* are not the same as rules presumed in the simulation.

[54] I compute the effective number of parties using the measure suggested by Golosov (2010): $N_p = \sum_1^x s_i/(s_i + s_1^2 - s_i^2)$, where s_i is the share of votes for party i and s_1 is the largest share. The computed "number of parties" uses s_i equal to the share of the sample with a stated party preference that states a preference for each coalition in Pappi and Thurner (2002, 221, Table 2). For the CDU-FDP coalition the vector of shares, calculated using the data in Pappi and Thurner (2002, 221, Table 2) for party preferences in the order (CDU/CSU, SPD, FDP, Greens, PDS), is $s = [0.8965, 0.02528, 0.06992, 0.004142, 0.004146]$ and for the SPD-Greens coalition the vector is $s = [0.002944, 0.8163, 0.0, 0.1453, 0.03552]$.

graphs seem to be spurious artifacts of the true relationships that are much better captured in Figures 24(c) and 24(b).

In some respects, the differences between the patterns in Greens and FDP support persist through subsequent years. Patterns in the differences between *Erststimmen* and *Zweitstimmen* shares are similar in the elections of 2002, 2005 and 2009 to what they were during 1994 and 1998. $\mathfrak{D}_{\text{SPD}}$ is clearly more strongly associated with $\mathfrak{D}_{\text{Greens}}$ than with $\mathfrak{D}_{\text{FDP}}$ (Figure 25(b) versus 25(a)), and $\mathfrak{D}_{\text{CDU}}$ is more strongly associated with $\mathfrak{D}_{\text{FDP}}$ than with $\mathfrak{D}_{\text{Greens}}$ (Figure 25(c) versus 25(d)): likely coalition partners cohere more. In Figure 25(b), as in Figure 23(b), a small number (33) of *Wahlkreis* have $\mathfrak{D}_{\text{Greens}} < 0$ and $\mathfrak{D}_{\text{SPD}} > 0$, while a much larger number (750) have $\mathfrak{D}_{\text{Greens}} > 0$ and $\mathfrak{D}_{\text{SPD}} < 0$.[55] Likewise in Figure 25(c), as in Figure 23(c), a small number (11) of *Wahlkreis* have $\mathfrak{D}_{\text{FDP}} < 0$ and $\mathfrak{D}_{\text{CDU}} > 0$, while many more (827) have $\mathfrak{D}_{\text{FDP}} > 0$ and $\mathfrak{D}_{\text{CDU}} < 0$.[56] In 2002–2009 as in the earlier years, the pattern in which the small party has many more *Zweitstimmen* than *Erststimmen* is nearly ubiquitous for the FDP and not quite as prevalent for Greens.

*** Figure 25 about here ***

In terms of $\hat{\jmath}_{xy}$, the pattern for Greens is similar during 2002–2009 to what it was during 1994–1998. When, in Figure 26(b), $\mathfrak{D}_{\text{Greens}} < 0$ and $\mathfrak{D}_{\text{SPD}} > 0$, then $\hat{\jmath}_{xy} \approx \bar{\jmath}$ except near the points where $(\mathfrak{D}_{\text{Greens}}, \mathfrak{D}_{\text{SPD}}) \approx (-.21, .17)$ or $(\mathfrak{D}_{\text{Greens}}, \mathfrak{D}_{\text{SPD}}) \approx (-.19, .04)$, near which respectively $\hat{\jmath}_{xy} \approx 4.35$ and $\hat{\jmath}_{xy} \approx 4.0$. Only in these two extreme cases is there evidence of strategic *Zweitstimmen* vote switching, and in the face of $\mathfrak{D}_{\text{Greens}} \approx -.21$ the value $\hat{\jmath}_{xy} \approx 4.35$ oddly suggests the Greens party was gaining *Zweitstimmen*.[57] In the part of Figure 26(b) that overlaps with Figure 24(b) and where $\mathfrak{D}_{\text{Greens}} < 0$ and $\mathfrak{D}_{\text{SPD}} > 0$, the values of $\hat{\jmath}_{xy}$ are similar. When during 2002–2009 $\mathfrak{D}_{\text{Greens}} > 0$ and $\mathfrak{D}_{\text{SPD}} < 0$, again in Figure 26(b), $\hat{\jmath}_{xy}$ decreases as $\mathfrak{D}_{\text{Greens}}$ increases, similar to the pattern for 1994–1998 in Figure 24(b): voters who sincerely favor the minor party still seem to be switching their *Erststimmen* to the major party in accord with wasted vote logic.

*** Figure 26 about here ***

The pattern for $\hat{\jmath}_{xy}$ for FDP during 2002–2009 is however essentially the reverse of the pattern for FDP during 1994–1998. Figure 26(c) shows that during 2002–2009 $\hat{\jmath}_{xy}$ decreases steadily as $\mathfrak{D}_{\text{FDP}}$ increases—$\hat{\jmath}_{xy}$ goes from $\hat{\jmath}_{xy} \approx 4.35$ to $\hat{\jmath}_{xy} \approx 3.8$—while during 1994–1998, in Figure 24(c), $\hat{\jmath}_{xy}$ increases as $\mathfrak{D}_{\text{FDP}}$ increases, going from $\hat{\jmath}_{xy} \approx 3.85$ up to $\hat{\jmath}_{xy} \approx 4.3$. The $\mathfrak{D}_{\text{FDP}}$ values suggests there was more coalition-insuring strategic vote switching in favor of the FDP during the latter years—$\mathfrak{D}_{\text{FDP}}$ has a higher maximum during 2002–2009 than during 1994–1998 ($\max \mathfrak{D}_{\text{FDP}} \approx .14$ versus $\max \mathfrak{D}_{\text{FDP}} \approx .09$)[58]—and the $\hat{\jmath}_{xy}$

[55] In 2002, 2005 and 2009, respectively, there are in Bavaria 7, 4 and 1 *Wahlkreis* with $\mathfrak{D}_{\text{Greens}} < 0$ and $\mathfrak{D}_{\text{SPD}} > 0$, in Saxony 2, 1 and 4 and in Saxony-Anhalt 2, 1 and 0. A scattering of single *Wahlkreise* occur in other *Länder*.

[56] The *Wahlkreise* with $\mathfrak{D}_{\text{FDP}} < 0$ and $\mathfrak{D}_{\text{CDU}} > 0$ all occur in 2002, and nine of them are in Bavaria.

[57] These two *Wahlkreise* are both *Wahlkreis* number 84, Friedrichshain-Kreuzberg-Prenzlauer Berg Ost, Berlin, in 2005 and 2009 respectively. In both years a Greens party candidate won the *Erststimmen* in the *Wahlkreis*, even though both SPD and Die Linke candidates were also on the ballot.

[58] The proportion of *Erststimmen* for FDP was higher during 2002–2009 than during 1994–1998. The proportion averaged .025 during 1994–1998 but .049 during 2002–2009.

values suggest that the composition of the set of voters supporting FDP had in this way become more diverse. The pattern of $\hat{\jmath}_{xy}$ values in 2002–2009 resembles the pattern in the symmetric simulation of Figure 2(b), unlike the pattern of 1994–1998 which resembles the asymmetric simulation summarized in Table 1. In line with the interpretation used above in connection with 1994–1998, we continue to associate apprarent symmetry in strategic behavior with greater diversity.

Figures 26(a) and 26(d), which show $\hat{\jmath}_{xy}$ estimated using covariates $(\mathfrak{D}_{\mathrm{CDU}}, \mathfrak{D}_{\mathrm{FDP}})$ and $(\mathfrak{D}_{\mathrm{SPD}}, \mathfrak{D}_{\mathrm{Greens}})$, seem to be spurious artifacts of the true relationships—motivated by potential coalition considerations—that are much better captured in Figures 26(c) and 26(b). This is similar to the situation in Figure 24.

Another approach when studying strategies in *Zweitstimmen* is to estimate $\hat{\jmath}_{xy}$ using as covariates a combination of $\mathfrak{D}_k$ for a small party and a margin $\mathfrak{M}_{13}$ or $\mathfrak{M}_{23}$ for a large party. Using data from 1994–1998, $\hat{\jmath}_{xy}$ for the digits of Greens *Zweitstimmen* varies significantly with either SPD or CDU/CSU margins $\mathfrak{M}_{13}$ or $\mathfrak{M}_{23}$ in combination with $\mathfrak{D}_{\mathrm{Greens}}$. Probably the relationships involving CDU/CSU margin $\mathfrak{M}_{23}$ are spurious and only the relationships involving Greens's likely coalition partner SPD are meaningful. Figure 27(a), which shows $\hat{\jmath}_{xy}$ estimated using $\mathfrak{D}_{\mathrm{Greens}}$ and SPD margins $\mathfrak{M}_{13}$, has contours that are largely vertical for $\mathfrak{D}_{\mathrm{Greens}} > 0$ but more nearly horizontal for $\mathfrak{D}_{\mathrm{Greens}} < 0$. For $\mathfrak{D}_{\mathrm{Greens}} > 0$, $\hat{\jmath}_{xy}$ increases—from about 4.0 to about 4.35—as $\mathfrak{M}_{13}$ increases: apparently Greens tended to receive more coalition-aware votes in places where SPD was winning by a larger margin. But when $\mathfrak{D}_{\mathrm{Greens}} < 0$—the number of *Erststimmen* for Greens exceeds the number of *Zweitstimmen* even though SPD wins in the *Erststimmen* (SPD wins in all the *Wahlkreise* in Figure 27(a))—$\hat{\jmath}_{xy}$ does not depend so much on $\mathfrak{M}_{13}$. In contrast, Figure 27(b) shows largely horizontal contours when $\mathfrak{M}_{23}$ is used: $\hat{\jmath}_{xy}$ does not much depend on the margin between SPD and the third-place party in places where SPD finished in second place, except where $\mathfrak{M}_{23} < .1$ and $-.02 < \mathfrak{D}_{\mathrm{Greens}} < .02$. There is evidence of an asymmetric strategic boost in Greens *Zweitstimmen* only when SPD manages to win big.

*** Figure 27 about here ***

Whether SPD finishes first or second in the *Erststimmen* seems to make a big difference, so it may be informative to divide the data used in Figure 24(b) into subsets depending on the outcome of the election in each *Wahlkreis*. The results of doing this are shown in Figures 27(c) and 27(d). Even though the two plots cover slightly different spans of $(\mathfrak{D}_{\mathrm{Greens}}, \mathfrak{D}_{\mathrm{SPD}})$ values, the values of $\hat{\jmath}_{xy}$ in the two plots for corresponding values of $(\mathfrak{D}_{\mathrm{Greens}}, \mathfrak{D}_{\mathrm{SPD}})$ are virtually the same. The similarity of Figures 27(c) and 27(d) suggests that the mechanism of coalition-aware voting involving Greens and SPD parties is the same no matter whether SPD finishes first or second, even though Figures 27(a) and 27(b) show that the occasions for such strategic voting differ. If we treat values of $\hat{\jmath}_{xy} \approx 4.3$ as a marker for when the Greens party is asymmetrically receiving strategic *Zweitstimmen*, then the magnitude of such voting seems to be about 2.5 percent (because $\mathfrak{D}_{\mathrm{Greens}} \approx .025$ then), and interestingly this locus occurs when both $\mathfrak{D}_{\mathrm{Greens}}$ and $\mathfrak{D}_{\mathrm{SPD}}$ are positive. Of course it is impossible to say for sure because of ecological inference complexities, but the most direct interpretation is that these votes are not "threshold insurance" type votes going to Greens from SPD supporters, but instead the votes are in places where both SPD and Greens gained *Zweitstimmen* support from voters who selected another party in their *Erstimmen.* This resonates with Gschwend's (2007, 15) finding little support for the "Coalition Insurance Hypothesis" with respect to Greens and with Shikano, Herrmann and Thurner's (2009, 650) finding that votes for the Greens were not particularly sensitive to uncertainty about the prospect that Greens would enter the Bundestag.

Using data from 1994–1998, $\hat{j}_{xy}$ for the digits of FDP *Zweitstimmen* also varies significantly with either SPD or CDU/CSU margins $\mathfrak{M}_{13}$ or $\mathfrak{M}_{23}$ in combination with $\mathfrak{D}_{\mathrm{FDP}}$. Probably the relationships involving the SPD margins are spurious and only the relationships involving the FDP's likely coalition partner CDU/CSU are meaningful. Both Figure 28(a), which shows $\hat{j}_{xy}$ estimated using $\mathfrak{D}_{\mathrm{FDP}}$ and CDU/CSU margin $\mathfrak{M}_{13}$, and Figure 28(b), which uses $\mathfrak{M}_{23}$, have contours that are largely horizontal, although $\hat{j}_{xy}$ is partly a function of $\mathfrak{M}_{13}$ for $\mathfrak{D}_{\mathrm{FDP}} < 0$. In both plots $\hat{j}_{xy}$ does not vary all that much from $\hat{j}_{xy} = \bar{j}$ for $\mathfrak{D}_{\mathrm{FDP}} > 0$. The CDU/CSU margins $\mathfrak{M}_{13}$ and $\mathfrak{M}_{23}$ are not informative covariates in this analysis. As was the case with Greens, dividing the data used in Figure 24(c) into subsets depending on the outcome of the *Erststimmen* in each *Wahlkreis* does not produce evidence of differences in the coalition-aware mechanism between the different types of *Wahlkreise.* In both Figures 28(c) and 28(d), contours of $\hat{j}_{xy}$ are largely horizontal, and the values of $\hat{j}_{xy}$ are similar for corresponding values of $(\mathfrak{D}_{\mathrm{FDP}}, \mathfrak{D}_{\mathrm{CDU}})$. The plan by elites to form a CDU/CSU-FDP coalition at the federal level apparently had relatively homogeneous federal level implications for the strategies voters were using.

*** Figure 28 about here ***

Using estimates of $\hat{j}_{xy}$ based on 2002–2009 data and the $\mathfrak{D}_{\mathrm{Greens}}$, $\mathfrak{M}_{13}$ and $\mathfrak{M}_{23}$ covariates suggests there were slight changes in the strategies affecting Greens support from 1994–1998 to 2002–2009. The estimates of $\hat{j}_{xy}$ for Greens *Zweitstimmen* digits that use covariates $\mathfrak{D}_{\mathrm{Greens}}$ and $\mathfrak{M}_{13}$, with data from *Wahlkreise* where SPD finished first in the *Erststimmen* (Figure 29(a)) resemble the estimates for 1994–1998 in Figure 27(a) in that the contours of $\hat{j}_{xy}$ are positively sloped when $\mathfrak{D}_{\mathrm{Greens}} > 0$ and negatively sloped when $\mathfrak{D}_{\mathrm{Greens}} < 0$. When $\mathfrak{M}_{23}$ is used with data from *Wahlkreise* where SPD finished second in the *Erststimmen* (Figure 29(b)), $\hat{j}_{xy}$ rises less rapidly as a function of $\mathfrak{M}_{23}$ than $\hat{j}_{xy}$ increases as a function of $\mathfrak{M}_{13}$ in Figure 29(a). For $\mathfrak{D}_{\mathrm{Greens}} > 0$, $\hat{j}_{xy}$ for 2002-2009, in Figure 29(b), resembles $\hat{j}_{xy}$ for 1994–1998 in Figure 27(b). These similarities between 1994–1998 and 2002–2009 suggests that SPD and Greens had essentially the same strategic relationship across those years. Changes become evident when Figures 29(c) and 29(d) are compared to Figures 27(c) and 27(d). In Figure 27(c) the locus where $\hat{j}_{xy} \approx 4.3$ is where both $\mathfrak{D}_{\mathrm{Greens}}$ and $\mathfrak{D}_{\mathrm{SPD}}$ are positive but in Figure 29(c) the locus of such values occurs where $\mathfrak{D}_{\mathrm{SPD}} < 0$ and $\mathfrak{D}_{\mathrm{Greens}}$ spans both positive and negative values near zero. On a direct interpretation the values of $\hat{j}_{xy} \approx 4.3$ in 2002–2009 where $\mathfrak{D}_{\mathrm{SPD}} < 0$ and $\mathfrak{D}_{\mathrm{Greens}} > 0$ suggest these are *Wahlkreise* where there were coalition-aware votes: the SPD had more *Erststimmen* than *Zweitstimmen* while Greens had more *Zweitstimmen* than *Erststimmen.* Values of $\hat{j}_{xy}$ in Figure 29(d) are also elevated for the same range of $(\mathfrak{D}_{\mathrm{SPD}}, \mathfrak{D}_{\mathrm{Greens}})$ values, although $\hat{j}_{xy}$ rises only to $\hat{j}_{xy} \approx 4.22$. A possible explanation for the difference between time periods is the experience of having an SPD-Greens governing federal coalition after the 1998 election. That experience possibly prompted a number of SPD *Erststimme* voters to give their *Zweitstimmen* to Greens. Of course the results of the 2002 election supported the formation of yet another SPD-Greens governing coalition.

*** Figure 29 about here ***

For FDP *Zweitstimmen* the main difference between $\hat{j}_{xy}$ in 2002–2009 and in 1994–1998 is that $\hat{j}_{xy}$ increases as $\mathfrak{D}_{\text{FDP}}$ increases in Figure 28 but decreases as $\mathfrak{D}_{\text{FDP}}$ increases in Figure 30. In Figure 30(a) $\hat{j}_{xy}$ with covariates $\mathfrak{D}_{\text{FDP}}$ and $\mathfrak{M}_{13}$ is as high as $\hat{j}_{xy} \approx 4.35$, but this high value is associated with too few *Wahlkreise* to be meaningful. In Figure 30(b) $\hat{j}_{xy}$ does not vary with $\mathfrak{M}_{23}$ much at all, given $\mathfrak{D}_{\text{FDP}}$. Figure 30(c) shows that the contours of $\hat{j}_{xy}$ in *Wahlkreise* where CDU/CSU won in the *Erststimmen* are generally horizontal but become vertical for a particular range of covariates, namely when $\mathfrak{D}_{\text{FDP}} < 0$ and $\mathfrak{D}_{\text{CDU}} > 0$. These observations correspond to a strange set of *Wahlkreise*—the direct interpretation of the $\mathfrak{D}_{\text{FDP}}$ and $\mathfrak{D}_{\text{CDU}}$ values is that *Zweitstimmen* are being switched from the small party to the large party—but few observations have these covariate values (recall Figure 25(c)), so it's unlikely the $\hat{j}_{xy}$ values are meaningful. In Figure 30(d), based on *Wahlkreise* where CDU/CSU finished second in the *Erststimmen*, the contours of $\hat{j}_{xy}$ are horizontal. Overall there is not much evidence of local variations in the voting strategies that connect FDP and CDU/CSU.

*** Figure 30 about here ***

4.2 Fukushima Shock and Green Mobilization in Baden-Württemburg

In the Baden-Württemburg *Landtagswahl* (state legislative election), each voter casts a single vote which is counted twice—once for an individual candidate and once for a party—in tallies to determine who wins seats in the *Landtag* (parliament) (Innenministerium Baden-Württemberg 2011; LPB 2011*b*). Across the elections of 2001, 2006 and 2011 there is a substantial oscillation in turnout. As Table 15 shows, between the 2001 and 2006 elections the number of electors (eligible voters) increased but turnout decreased.[59] Turnout declined from 63 percent to 53 percent between 2001 and 2006, then increased to 66 percent in 2011. Schlipphak and Eith (2008) attributes the decline in 2006 in part to the Bundestag election held in September 2005. Voters generally and supporters of SPD in particular were disenchanted by the CDU-SPD grand coalition government the Bundestag election produced. As Table 15 shows, the smaller parties—Green[60] and FDP—gained from 2001 to 2006 in terms of absolute vote counts while SPD and CDU each received fewer votes.[61] The proportion of votes received by SPD decreased substantially, from 33.3 percent to 25.2 percent, while CDU's proportion decreased only slightly, from 44.8 percent to 44.2 percent.

*** Table 15 about here ***

[59]Turnout is the number of voters (*Wähler(innen)*) divided by the number of electors (*Wahlberechtigte*).

[60]Here "Green" refers to *Bündnis 90/Die Grünen*.

[61]Polls show that in 2006 in net terms 31,000 voters switched to FDP from voting for SPD in the 2001 election while 63,000 switched to FDP from CDU (Neu 2006, 13).

Both absolute and proportional support for Green increases not only in 2006 but also in 2011. After declining by more than a third between 1996 and 2001 (King 2001; LPB 2011*a*), votes for Green increased between 2001 and 2006, from 350,383 to 462,889. Polls show that while in 2001 Green gained only 58,000 net votes from those who had supported another party in 1996, and 79,000 of those who voted Green in 1996 did not vote in 2001, in 2006 Green gained 89,000 net votes from those who had supported another party in 2001 (Wahlen.kas.de 2001; Neu 2006, 12–13). This increase in the Green vote was remarkable in that it prompted talk of a CDU-Green coalition government, even though that did not occur (Gabriel 2006). In 2006 in net terms 86,000 voters switched from having voted for SPD in 2001 to voting for Green in 2006 while 38,000 switched from SPD to CDU (Neu 2006, 12–13). The 2011 *Landtagswahl* occurred shortly after the Fukushima nuclear power plant meltdown in Japan: the Fukushima event began on March 11 and the *Landtagswahl* was on March 27 (Dehmer 2011; Sanger and Wald 2011). In 2011 turnout increased, to 66 percent, and the Green proportion of the vote more than doubled: Green received 24.2 percent of the total of valid ballots (see Table 15). After the 2011 election, CDU was out of the governing coalition for the first time in 58 years—a Green-SPD governing coalition formed—and the Green party had a prime minister (minister-president) for the first time ever in Germany (Muno and Linnenbrink 2011; Tiesenhausen 2011). Notwithstanding the presence of SPD in the governing coalition, the proportion of votes for SPD in 2011 decreased slightly from the proportion SPD received in 2006: in 2011, SPD received 23.1 percent of the votes, down from 25.2 percent in 2006.

The fact that each voter casts only a single vote in the *Landtagswahl* means that there are no *Zweitstimmen* that are counted using PR rules against which to compare votes that are counted using a plurality rule. Indeed, both PR and plurality rules are applied to the very same votes in the Baden-Württemburg *Landtagswahl*. Nonetheless, the second digits of the polling station votes counts reflect the differences across elections in strategy, mobilization and impetus that affect vote counts for the various parties.

Differences across election years and parties are apparent in the unconditional statistics χ^2_{2BL} and $\hat{j}$, shown in Table 16. In 2001, χ^2_{2BL} does not suggest any significant departure from 2BL if $\hat{\alpha}$ is used to assess significance, although for CDU that year $\hat{\alpha} = .07$. $\hat{j} > \bar{j}$ significantly for CDU and FDP but not for SPD or Green. In 2006, χ^2_{2BL} indicates significant departures from 2BL for SPD and FDP but not for CDU or Green. $\hat{j} < \bar{j}$ significantly for SPD and $\hat{j} > \bar{j}$ significantly for FDP, but $\hat{j}$ does not differ significantly from $\bar{j}$ for CDU or Green. $\hat{j}$ for FDP does not differ significantly from $\hat{j} \approx 4.35$, which is the value for $\hat{j}$ seen in Table 1 when a party is simulated receiving strategically switched votes. $\hat{j} \approx 3.8$ for SPD is similar to the value of $\hat{j}_x$ in Figure 2(d), the simulation in which some of the votes a party receives are coerced. In 2011, χ^2_{2BL} indicates significant departures from 2BL for SPD and Green but not for CDU or FDP. $\hat{j} < \bar{j}$ significantly for both SPD and Green, but $\hat{j}$ does not differ significantly from $\bar{j}$ for CDU or FDP. $\hat{j} \approx 3.8$ for SPD and $\hat{j} \approx 3.9$ for Green are again similar to the value of $\hat{j}_x$ in Figure 2(d).

*** Table 16 about here ***

The most striking change over years in these elections is the large oscillation in turnout, so it is interesting to see how variations in turnout are associated with variations in $\hat{j}$. Are the sources of variation in turnout reasonably interpreted as “coercive”? It is important to note that the simulation that produces Figure 2(d) does not try to measure the effect on digits of a coerced reduction in votes, that is, the effect of a reduction votes that does not depend on preferences. So if there is an association between substantial turnout decline and $\hat{j}$, the simulation does not provide a direct basis for interpreting that association. On the other hand, the shock that produced the jump up in votes for Green in 2011 may be susceptible to being diagnosed a kind of “coercion” akin to what the simulation that produces Figure 2(d) represents.

Because one or more of the increases in votes for Green may match the simulation, let's begin with those. In fact differences in why Green party candidates received votes in the respective elections correspond to differences in $\hat{j}_{xy}$ for the Green votes across the 2001, 2006 and 2011 elections.

In 2011 the high level of voting for Green was due to mobilization (higher turnout) and especially due to the shock of the Fukushima incident which began on March 11 in Japan—16 days before the election on March 27. Survey data show Green achieved the historic result through a large mobilization of previous nonvoters, combined with a large number of defections from the other parties. Specifically, polls in 2011 show that in net terms Green received 266,000 votes from those who were nonvoters in 2006, 132,000 from new or first-time voters, 140,000 votes from former SPD voters, 87,000 votes from former CDU voters, 61,000 votes from former FDP voters, and 33,000 votes from former Die Linke supporters (Neu and Borchard 2011, 10). In contrast CDU, which overall received 1,943,912 votes compared to 1,206,182 votes for Green, in net terms received only 266,000 votes from previous nonvoters and new or first-time voters and gained only from former FDP voters—66,000 votes—while losing 131,000 votes to SPD, Green and Die Linke (Baden-Württemberg 2012; Neu and Borchard 2011, 9).

The effect of Fukushima was widely acknowledged at the time (Muno and Linnenbrink 2011), and the effect of the incident on support for Green is clearly apparent in opinion survey data.[62] As Figure 31(a) shows, Green support in response to questions asking how the respondent would vote “if the parliamentary elections were held next Sunday” had roughly doubled during 2010—due largely to a federal controversy whether and then decision (on October 28, 2010) to extend the life of several nuclear power plants (Deutscher Bundestag 2010)—but had fallen substantially by the beginning of March, 2011. Immediately after Fukushima, Green support increased sharply (Kamann and Hollstein 2011). Responses to the same question expressing support for other parties, plotted in Figures 31(b–d), show the Fukushima event prompted a sharp drop in support for SPD and FDP, and it curtailed a rise that had started late in 2010 in support for CDU. In a survey[63] fielded March 14–17—immediately after the Fukushima event began—87 percent of respondents said “energy and nuclear policy” was important or very important for their vote choice. In contrast, 91 percent said “school and education policy” was similarly important, and 85 percent said “economic policy” was important or very important. Sixty-one percent of respondents agreed that “the Greens have the risks of nuclear power

[62] Opinion survey data were compiled from surveys conducted by a variety of survey organizations by Cantow, Fehndrich, Schneider and Zicht (2012).

[63] The survey (Infratest dimap 2011) had 1,250 respondents overall and 750 respondents for the questions about critical issues and nuclear power.

better assessed than other parties." The Fukushima event was indeed a shock that strongly and suddenly affected the election, both converting voters who previously supported other parties to become Green supporters and mobilizing new voters who disproportionately supported Green.

*** Figure 31 about here ***

The differences in the origins of votes for Green in the 2001, 2006 and 2011 elections leave distinctive traces in the digits of the polling station vote counts, and particularly they are evident in $\hat{j}_{xy}$. Because each voter casts at most a single vote in each of these elections, covariates to be used to estimate $\hat{j}_{xy}$ cannot include $\mathfrak{D}_k$, the difference in each *Wahlkreis* between district-plurality (*Erststimme*) and proportional representation (*Zweitstimme*) vote proportions for party k. Margins between different parties in each *Wahlkreis* may be computed, however.[64] Hence I consider *Wahlkreise* in which CDU won (SPD was usually second), and for one covariate I use the margin $\mathfrak{M}_{13}$. For the other covariate I use the margin between the *Wahlkreis*-winning party (always CDU) and Green; denote this margin by $\mathfrak{M}_{1G}$.

Comparing $\hat{j}_{xy}$ across the elections shows no sign of strategic or special gains for Green anywhere in 2001, some sign of that in 2006 and signs of substantial mobilization of new voters to vote Green in 2011. In 2001 (Figure 32(a)), $\hat{j}_{xy}$ takes values $\hat{j}_{xy} \approx \bar{j}$ and is not a significant function of either covariate.[65] In 2006 (Figure 32(b)), $\hat{j}_{xy}$ increases significantly as a function of both covariates,[66] increasing from $\hat{j}_{xy} \approx 3.75$ to $\hat{j}_{xy} \approx 4.3$. While (unlike $\mathfrak{D}_k$) $\mathfrak{M}_{1G}$ is not immediately interpretable as an indicator of strategic switching, $\hat{j}_{xy}$ increases with $\mathfrak{M}_{1G}$ and $\mathfrak{M}_{13}$ much as it did as a function of $\mathfrak{M}_{13}$ (for *Wahlkreis* where SPD won) in Figure 27(a) for $\mathfrak{D}_{\text{Green}} > 0$.[67] In Figure 27(a) $\hat{j}_{xy}$ was not a function of $\mathfrak{D}_{\text{Green}}$, and it may well be that $\hat{j}_{xy}$ in Figure 32(b) is in fact solely a function of $\mathfrak{M}_{13}$: $\mathfrak{M}_{13}$ and $\mathfrak{M}_{1G}$ are so highly correlated that it is impossible to discriminate their respective effects. As in the federal elections of 1994–1998 that were the focus in Figure 27(a), it appears that in the 2006 Baden-Württemberg election there was coalition-aware voting in favor of Green that increased with $\mathfrak{M}_{13}$.[68] In 2011 (Figure 32(c)), $\hat{j}_{xy}$ is again significantly a function of the covariates,[69] but in this case the pattern of $\hat{j}_{xy}$ resembles the pattern in Figure 2(d), which summarizes the simulation that represents the digits in vote counts when there is strategic voting with "coercion." $\hat{j}_{xy}$ in Figure 32(c) ranges from about $\hat{j}_{xy} \approx 3.78$ to about $\hat{j}_{xy} \approx 4.04$. This range is almost exactly the range that can be seen in $\hat{j}_x$ in Figure 2(d) for the disadvantaged candidate. The election rules and the number of parties in the Baden-Württemberg election are so different from the conditions assumed in

[64] Data files from Baden-Württemberg (2012) includes *Wahlkreis* numbers for 2011, but for 2001 and 2006 *Wahlkreis* numbers needed to be constructed using variable `GKZ` for 2001 and variable `RKZ` for 2006. These variables were crossreferenced with links at Wikipedia (2012), which has sources Obrembalski (2010), Landtag von Baden-Württemberg (2010) and Baden-Württemberg (2009, 533–534).

[65] `sm.regression()` reports "Test of no effect model: significance = 0.12" for these contours.

[66] `sm.regression()` reports "Test of no effect model: significance = 0" for these contours.

[67] See page 27.

[68] The pattern in $\hat{j}_{xy}$ is similar if, for *Wahlkreis* where SPD was second, $\mathfrak{M}_{23}$ is used as the covariate instead of $\mathfrak{M}_{13}$.

[69] `sm.regression()` reports "Test of no effect model: significance = 0.024" for these contours.

the simulated election used to produce Figure 2(d) that it is not all that meaningful numerically to compare, say, $\mathfrak{M}_{1G}$ to the "2d candidate advantage" used as the covariate in Figure 2(d). Nonetheless the variation in $\hat{j}_{xy}$ as $\mathfrak{M}_{1G}$ ranges over $.05 < \mathfrak{M}_{1G} < .35$ matches the variation in $\hat{j}_x$ as "2d candidate advantage" ranges from 0 to .6. The shock of the Fukashima incident—inducing a substantial mobilization of new voters—seems to have an effect on the second digits of vote counts for Green that corresponds to the artificial push used in the simulation to induce ("coerce") an entire class of voters to cast votes for the simulated candidate.

*** Figure 32 about here ***

Three different elections with distinctive electoral dynamics lead to three distinctive patterns in the vote counts' second digits. When, in 2001, Green is not the focus of anything special in the election and only their core supporters are with them, then $\hat{j}_{xy}$ is not related to covariates and $\hat{j}_{xy} \approx \bar{j}$. But when in 2006 Green receives some votes based on voters defecting from another party (SPD), then $\hat{j}_{xy}$ increases with margins between parties in a manner suggestive of strategic vote switching. And when, in 2011, an unusual shock prompts many new voters to turn out and vote Green, that special mobilization causes $\hat{j}_{xy}$ to decrease in association with the margins in a pattern that resembles the pattern seen when strategic voting with coercion is simulated. The digit patterns are diagnostic of how voters are behaving in the various elections.

A way explicitly to bring in changes in turnout over time is to use as a covariate a measure of changes in turnout in each locality. Ideally this measure would be the change in turnout in each *Wahlkreis*, but unfortunately *Wahlkreis* definitions vary over time so that it is not advisable to try to compare turnout in *Wahlkreise* across years. Instead we consider the change in turnout in each *Gemeinde* (community).[70] Use $\mathfrak{T}_\Delta$ to denote these turnout change values. To estimate $\hat{j}_{xy}$ I use $\mathfrak{T}_\Delta$ for one covariate and $\mathfrak{M}_{13}$ or $\mathfrak{M}_{23}$ for the other.

Computing $\hat{j}_{xy}$ this way for Green votes in 2011 in *Wahlkreise* where Green finished either first or second reveals an important distinction between the two kinds of *Wahlkreise*. In neither case is $\hat{j}_{xy}$ significantly a function of the covariates, although in the *Wahlkreise* where Green was second the results are close to significance with a p-value of .081: $\hat{j}_{xy}$ in *Wahlkreise* where Green was first is shown in Figure 33(a),[71] and $\hat{j}_{xy}$ for *Wahlkreise* where Green was second appears in Figure 33(b).[72] The values of $\hat{j}$ when $\hat{j}$ is evaluated separately for each *Wahlkreis* differ between the two types of *Wahlkreise*. When $\hat{j}$ is evaluated in each *Wahlkreis* where Green won, the mean of the $\hat{j}$ values is 4.28 (s.e. = .086), which does not differ significantly from the value $\hat{j} = 4.35$ produced for parties that gained strategically switched votes in Table 1. The mean of $\hat{j}$ when $\hat{j}$ is evaluated in each *Wahlkreise* where Green finished second is 3.84 (s.e. = .044), which is significantly less than 4.35. The two means differ significantly from one another. Even though $\hat{j}_{xy}$ is not significantly a function

[70]In the data from Baden-Württemberg (2012), the number of *Gemeinden* with the same name across years and with nonmissing data for both the `Wahlberechtigte` (eligible voters) and `Wahler` (voters) or `Wahler(innen)` variables is 1,118 for 2001–2006 and 1,092 for 2006–2011. Turnout in each *Gemeinde* is the ratio of the number of voters to the number of eligible voters.

[71]`sm.regression()` reports "Test of no effect model: significance = 0.301" for these contours.

[72]`sm.regression()` reports "Test of no effect model: significance = 0.081" for these contours.

of the covariates, the difference between Figures 33(a) and 33(b) is noteworthy.[73] The nearly horizontal contours in Figure 33(b) suggests any variation in $\hat{j}_{xy}$ depends almost purely on $\mathfrak{T}_\Delta$ and not $\mathfrak{M}_{23}$, while in Figure 33(a) the contours are more diagonal and some are almost vertical. The *Wahlkreis* $\hat{j}$ values and these patterns in $\hat{j}_{xy}$ suggest that in *Wahlkreise* where Green won, strategic vote switching played a role, while there is no evidence of such behavior in *Wahlkreise* where Green finished in second place.

*** Figure 33 about here ***

$\hat{j}_{xy}$ for CDU suggests that differences in mobilization for CDU are strongly related to variation over *Gemeinden* in changes over time in turnout. $\hat{j}_{xy}$ for CDU using covariates $\mathfrak{T}_\Delta$ and $\mathfrak{M}_{13}$ in *Wahlkreise* where CDU won is significantly a function of the covariates, and the contours in $\hat{j}_{xy}$ depend sharply on $\mathfrak{T}_\Delta$ (Figure 33(c)).[74] For $\mathfrak{T}_\Delta \leq 0$, the contours are diagonal and $\hat{j}_{xy}$ decreases as $\mathfrak{T}_\Delta$ increases: for $\mathfrak{M}_{13} \approx .21$, $\hat{j}_{xy} \approx 4.2$ when $\mathfrak{T}_\Delta \approx -.07$ and $\hat{j}_{xy} \approx 3.7$ when $\mathfrak{T}_\Delta \approx 0$. For $\mathfrak{T}_\Delta \geq 0$, the contours are more purely horizontal and $\hat{j}_{xy}$ increases as $\mathfrak{T}_\Delta$ increases: for $\mathfrak{M}_{13} \approx .15$, $\hat{j}_{xy} \approx 3.4$ when $\mathfrak{T}_\Delta \approx 0$ and $\hat{j}_{xy} \approx 4.8$ when $\mathfrak{T}_\Delta \approx .2$. In *Gemeinde* where turnout changed the most, it appears there was mobilization in favor of CDU that was not related to the margin between CDU and the party finishing third in the referent *Wahlkreis*.

In contrast, $\hat{j}_{xy}$ for SPD is not significantly or in any way systematically related to variation over *Gemeinden* in turnout changes. $\hat{j}_{xy}$ for SPD in *Wahlkreise* where SPD finished second is not a significant function of $\mathfrak{T}_\Delta$ or $\mathfrak{M}_{23}$ (Figure 33(d)).[75]

$\hat{j}_{xy}$ for SPD and for CDU does not significantly depend on variation over *Gemeinden* in turnout changes in 2006. Figure 34(a) shows $\hat{j}_{xy}$ for SPD in *Wahlkreis* where SPD finished second, and Figure 34(b) shows $\hat{j}_{xy}$ for CDU in *Wahlkreis* where CDU finished first.[76] The contours for both parties are horizontal, so if anything $\hat{j}_{xy}$ depends on $\mathfrak{T}_\Delta$ and not on $\mathfrak{M}_{23}$ or $\mathfrak{M}_{13}$. Because the differences across *Wahlkreise* and *Gemeinden* are not even close to significant, it is best not to try to interpret the variations in $\hat{j}_{xy}$ in any detail. The values of $\hat{j}$ when $\hat{j}$ is evaluated separately for each *Wahlkreis* differ between the two parties. When $\hat{j}$ for SPD is evaluated in each *Wahlkreis* where SPD was second, the mean of the $\hat{j}$ values is 3.77 (s.e. = .029), and when $\hat{j}$ for CDU is evaluated in each *Wahlkreis* where CDU won, the mean of the $\hat{j}$ values is 4.16 (s.e. = .028). Whatever caused the drop in turnout and in voting for SPD in 2006, with some decline but greater stability in voting for CDU (recall Table 15), the effect did not vary significantly across *Wahlkreise* or *Gemeinden*.

*** Figure 34 about here ***

Why $\hat{j}$ for SPD decreases in 2006 and continues with pretty much the same value in 2011 remains unclear. Perhaps disenchantment with the federal CDU-SPD coalition is the

[73] In *Wahlkreise* where Green was second, $\hat{j}_{xy}$ also comes close to depending significantly on the covariates if instead of $\mathfrak{T}_\Delta$ I use the proportional difference between years in `Gültige.Stimmen` (valid votes) in each *Gemeinde*. Then `sm.regression()` reports "Test of no effect model: significance = 0.088".

[74] `sm.regression()` reports "Test of no effect model: significance = 0" for these contours.

[75] `sm.regression()` reports "Test of no effect model: significance = 0.337" for these contours.

[76] `sm.regression()` reports "Test of no effect model: significance = 0.52" for the contours in Figure 34(a) and "Test of no effect model: significance = 0.175" for the contours in Figure 34(b).

shock that had the effect of coercing votes away from SPD in 2006, but SPD's vote totals rebounded somewhat in 2011. Of course, SPD's vote total in 2011 is closer to the total in 2006 than to the total in 2001. So perhaps the disenchantment that began in 2006 continued through 2011. Perhaps the Fukushima shock prevented a more complete rebound that would otherwise have occurred.

5 Canada

In Canadian federal elections Canadian voters have been found to act strategically—somewhat in accord with wasted vote logic. Blais and Nadeau (1996) and Blais et al. (2001) use survey evidence to show that expectations about the election outcome in local ridings[77] prompted many voters to switch their votes from weak parties to stronger and larger parties, although they find no evidence of nationally oriented coalition-aware behavior. Blais and Gschwend (2011, Table 8.1) report analogous supporting evidence. Chhibber and Kollman (2004) assess an aggregate implication such behavior should have if Duvergerian equilibria (Cox 1994, 1997) occur in each riding, namely that no more than two parties should receive a substantial number of votes in each riding. Chhibber and Kollman (2004) compute the effective number of parties in each riding and find that the average number of parties is slightly greater than two.[78] On the whole, however, Chhibber and Kollman (2004) find that there is persistent and widespread support in Canada for candidates who are not competitive in their ridings, a pattern they say is hard to square with a narrowly construed sense of instrumental rationality.

Computing the effective number of parties, N_p,[79] in ridings in federal elections from 1997 through 2011 confirms the persistence of patterns in which each riding typically has effectively just more than two parties but also shows substantial variation in the patterns over time.[80] Table 17 presents histograms that show the distribution of N_p across ridings in each election. The median of N_p, also reported in Table 17, ranges from a high of 2.42 in 1997 to a low of 2.23 in 2011, although the median does not monotonically decline over time but rather oscillates. The distribution of N_p around the median varies over the years. In some years (1997, 2004, 2008) the modal value of N_p is near $N_p \approx 2.5$ while in 2011 the mode is near $N_p \approx 2.0$. In most years the distribution is unimodal, but sometimes the distribution is bimodal (in years 2004 and 2011).

*** Table 17 about here ***

The appearance of great volatility in the distribution of N_p matches the fact of tremendous volatility in the different parties' electoral successes. Indeed, during the 1997–2011 period, major political parties came and went. The election returns reported in

[77] In Canada Members of Parliament are elected using a plurality rule in constituencies that are called "ridings."

[78] Precisely it is 2.27 with a standard deviation of .54 (Chhibber and Kollman 2004, Table 2.1).

[79] N_p is the effective number of parties computed using Golosov's (2010) formula, given in note 54 on page 25.

[80] I use these elections because polling station vote counts are available for them, from Elections Canada (2006*c*,*a*,*b*, 2010, 2012).

Table 18 tell the tale. The Liberal party had the most votes overall in 1997 and 2000, while the formerly governing Progressive Conservative party, having suffered devastating losses in the 1993 election (LeDuc 1994), experienced rapidly declining support across the two elections and indeed had disappeared by the 2004 election. The Reform party, having emerged in 1993 as a regional party, built support rapidly across the 1997 and 2000 elections, running in the latter election under the banner of the Canadian Alliance (LeDuc 1994; Andersen and Fox 2001; LeDuc 2002). In 2004, the Canadian Alliance merged with remnants of the Progressive Conservative party to form the new Conservative party (LeDuc 2005). Table 18 shows that the Conservative party's vote total in 2004 exceeded the 2000 total of either of the parties that merged to create it but not the total of both combined, so even though the Liberal party's vote total declined from the 2000 election it still received the most votes in 2004. The New Democratic Party (NDP) in 2004 had vote totals greater than it had in either of the two preceding elections, and the Bloc Québécois also gained. Among the many very small parties that received votes in the elections, Table 18 shows the vote totals for the Green party, whose still small vote total grew nearly tenfold from 1997 to 2004. In 2006 the Conservative party received the most votes, enough to take the lead in a minority government (LeDuc 2007), a situation essentially repeated in 2008 (LeDuc 2009). In 2011 the Conservative party finished first with enough support to form a majority government (LeDuc 2012). Support for the Liberal party steadily declined through 2006, 2008 and 2011. The votes for the Liberal party in 2011 were slightly more than half the number received in 2000. Compared to 2004, support for NDP increased by about 20 percent in 2006 and 2008 and nearly doubled in 2011. The 2011 election put NDP in position to become the Official Opposition (LeDuc 2012). Similarly measured against a 2004 baseline, the Bloc Québécois lost support in 2006 and 2008, and then in 2011 votes for the party dropped by nearly half.

*** Table 18 about here ***

For all the volatility in their ultimate choices, the strategies Canadian voters are using feature remarkable stability over time and similarity across parties when the strategies are assessed using the digits in polling station vote counts. While in a broad sense there is great stability and similarity in the patterns in the conditional digit mean $\hat{j}_x$, $\hat{j}_x$ also varies in ways that plausibly match variation in the strategic behaviors many Canadian voters were exhibiting at different times and regarding different political parties.

To diagnose any strategies being used by voters in these elections, $\hat{j}$ alone (as in Table 6) is insufficient, but given the fact of that votes were cast and tallied for different candidates in separate ridings, the margins between the parties in each riding are available to use as the conditioning variable when estimating $\hat{j}_x$. In particular the existence of plurality election rules, the persistence of many parties and, nonetheless, the evidence that wasted vote logic was used by many voters together motivate using the margins $\mathfrak{M}_{13}$ and $\mathfrak{M}_{23}$—respectively for winning and second-place candidates—as the covariate.

Figure 35 shows the results from estimating $\hat{j}_x$ with covariates $\mathfrak{M}_{13}$ and $\mathfrak{M}_{23}$ for several parties with polling station data from the 1997 election (Elections Canada 2006c).[81] To

[81]The n shown below each plot indicates the number of observations the function `sm.regression()` used to estimate $\hat{j}_x$, which is a subset of the polling stations at which the referent party had a vote count greater than nine.

estimate $\hat{j}_x$ I group together all ridings in which a particular pair of parties finished first and second. So the estimates shown in Figures 35(a) and 35(b) use data from all ridings in which either the Liberal party had the most and the Reform party the second most votes in the riding or the Reform party had the most and the Liberal party had the second most votes. Figure 35(a) shows $\hat{j}_x$ for the counts of votes cast for the Liberal party and Figure 35(b) shows $\hat{j}_x$ for the Reform party's votes counts. In general in these figures, $\hat{j}_x$ is computed using vote counts for the party named above each graphic. In Figure 35(a) $\mathfrak{M}_{13}$ is displayed as the positive part of the x-axis for ridings in which the Liberal party won and $-\mathfrak{M}_{23}$ as the negative part of the x-axis for ridings where Reform won. In general, the party named above each graph is the winning party whose riding votes are used to compute the $\mathfrak{M}_{13}$ values plotted to the right of zero on the x-axis, and that party is also the second-place party whose votes produce the $-\mathfrak{M}_{23}$ values that are plotted to the left of zero. The $\hat{j}_x$ estimates use as covariates the quantities shown on the x-axis. The other estimates of $\hat{j}_x$ and displays presented in this section are all constructed similarly and all have the same format.

*** Figure 35 about here ***

The estimates of $\hat{j}_x$ shown in Figures 35(a) and 35(b) are very similar to one another, and both are readily intelligible in strategic terms when the simulation results in Figures 1 and 2 are taken into account. In Figure 35(a), for the digits of Liberal party vote counts, in ridings where the party wins $\hat{j}_x$ starts off well below $\bar{j}$—$\hat{j}_x \approx 4.0$ when $\mathfrak{M}_{13} \approx .09$, which is the smallest observed value of $\mathfrak{M}_{13}$—then $\hat{j}_x$ decreases to its minimum value of about $\hat{j}_x \approx 3.6$ as $\mathfrak{M}_{13}$ increases to about $\mathfrak{M}_{13} \approx .32$. $\hat{j}_x$ then increases back to around $\hat{j}_x \approx 3.9$ for the largest observed $\mathfrak{M}_{13}$ value, which in Figure 35(a) is about $\mathfrak{M}_{13} \approx .47$. Likewise for the digits of the Reform party, in Figure 35(b), in ridings where this party wins $\hat{j}_x$ starts off below $\bar{j}$ when $\mathfrak{M}_{13} \approx .09$, decreases to its minimum value of about $\hat{j}_x \approx 3.6$ as $\mathfrak{M}_{13}$ increases to about $\mathfrak{M}_{13} \approx .35$ and then increases to around $\hat{j}_x \approx 3.9$ for the largest observed $\mathfrak{M}_{13}$ value, which in Figure 35(b) is about $\mathfrak{M}_{13} \approx .59$.

These portions of $\hat{j}_x$ most closely resemble the results for the advantaged party in the symmetric simulation with strategic voting, namely the dashed line in Figure 2(b). The correspondence is not perfect. The numerical values of $\hat{j}_x$ in Figure 35(a) for small positive values of $\mathfrak{M}_{13}$ do not precisely match the corresponding values of $\hat{j}_x$ for small values of the "2d candidate advantage" in Figure 2(b). The mismatches are likely innocuous, for two reasons. First, many parties received votes in the real election—and the number of parties is varying across ridings—while the simulation has votes for only three parties. Second, $\mathfrak{M}_{13}$ is conceptually not the same as "2d candidate advantage," because $\mathfrak{M}_{13}$ measures the gap between different candidates, namely, the first and the third. If instead in Figure 35(a) we use $\mathfrak{M}_{12}$ as the covariate, the numerical correspondence in $\hat{j}_x$ for small positive values of $\mathfrak{M}_{12}$ is somewhat closer.[82] The more substantial difference between the real data and the simulation is that the estimated $\hat{j}_x$ increases in Figure 35(a) as $\mathfrak{M}_{13}$ increases above

[82]If $\mathfrak{M}_{12}$ is the covariate instead of $\mathfrak{M}_{13}$, then over the interval $0 < \mathfrak{M}_{12} < .3$, the values of $\hat{j}_x$ almost exactly match the $\hat{j}_x$ values shown for the advantaged candidate in Figure 2(b) for "2d candidate advantage" taken over a similar interval.

$\mathfrak{M}_{13} \approx .32$ while the simulated $\hat{j}_x$ continues to decline.[83] The same pattern appears in Figure 35(a). I conjecture that this difference traces to the presence of multiple vote-getting parties in the real elections, more than the three parties allowed to get votes in the simulation.[84] Regardless of this difference for the higher values of $\mathfrak{M}_{13}$, the important result is that $\hat{j}_x$ for these winning parties in the ridings in which they won strongly resembles the pattern that exists when strategic voting is simulated.

In Figure 35(a) estimates $\hat{j}_x$ for ridings where Liberal party candidates finished second resemble results from for the disadvantaged party in the symmetric simulation with no strategic voting, namely the solid line in Figure 2(a). To some extent there is also resemblence to the simulation where there is gerrymander but no strategic voting, namely Figure 1. In Figure 35(a), $\hat{j}_x$ is at or below $\bar{j}$ when $\mathfrak{M}_{23} = 0$, then increases to peak above $\bar{j}$ and then decreases to again fall below $\bar{j}$ as $-\mathfrak{M}_{23}$ decreases. This pattern matches the behavior of $\hat{j}_x$ in Figure 2(a) where $\hat{j}_x$ is above $\bar{j}$ when "2d candidate advantage" is zero, then $\hat{j}_x$ decreases as "2d candidate advantage" increases above zero. Quantitatively $\hat{j}_x$ in the real data has a slightly greater value when $-\mathfrak{M}_{23} \approx 0$ than when "2d candidate advantage" is zero in Figure 2(a): real-data $\hat{j}_x \approx 4.31$. $\hat{j}_x$ in the real data also decreases as $-\mathfrak{M}_{23}$ decreases about as far as the simulated $\hat{j}_x$ does when "2d candidate advantage" increases: real-data $\hat{j}_x$ goes down to $\hat{j}_x \approx 4.02$. Strictly speaking, of course, $\mathfrak{M}_{23}$ cannot be matched to "2d candidate advantage" because $\mathfrak{M}_{23}$ involves different candidates, but nonetheless the quantitative similarity between $\hat{j}_x$ based on real data and the simulated values is close.

The qualitative resemblance between $\hat{j}_x$ in the real and in the simulated data may also be said to be close, but on this point the similarity to Figure 1 should be noted. In Figure 35(a) $\hat{j}_x$ rises a bit as $-\mathfrak{M}_{23}$ decreases before $\hat{j}_x$ decreases: $\hat{j}_x$ rises to a maximum of $\hat{j}_x \approx 4.39$ when $-\mathfrak{M}_{23} \approx -.055$. This value of $\hat{j}_x$ is slightly greater than the maximum values in Figure 1. But simulated $\hat{j}_x$ in Figure 2(a) does not increase at all as "2d candidate advantage" increases, while simulated $\hat{j}_x$ in Figure 1 does. Perhaps this effect is a consequence of the simulated $\hat{j}_x$ in Figure 2(a) not including any effect of turnout decline. A simulation in which there is a decline in turnout as the margin between the candidates gets larger would be a more appropriate one to consider in light of the finding in Berch (1989) that turnout was strongly related to closeness in the 1979 and 1980 elections: it is likely that is a typical pattern in Canada. Such a simulation produces results not materially different from those in Figure 2.[85] Also in Figure 1 $\hat{j}_x = \bar{j}$ by construction when "2d candidate advantage" is zero, but $\hat{j}_x$ in Figure 35(a) is significantly greater than $\bar{j}$ when $-\mathfrak{M}_{23} \approx 0$. So all things considered, the real-data $\hat{j}_x$ for second-place candidates in Figure 35(a) resembles Figure 2(a) more than Figure 1. The detailed quantitative match

[83]A similar upturn is apparent in when $\mathfrak{M}_{12}$ is the covariate.

[84]The median number of parties receiving a positive number of votes in a riding in Elections Canada (2006*c*) is 5. In all, there are 15 parties.

[85]When the asymmetric simulation that produces Figure 2(a) is run with the turnout decline factor set to -2 for both candidates, $\hat{j}_x$ does not increase for the selected values of "2d candidate advantage" (i.e., 0, .05, .1, .15, .2, .4, .5, .6) as "2d candidate advantage" increases, but also $\hat{j}_x$ does not decrease over the first three values. In this case for the disadvantaged candidate $\hat{j}_x = 4.22$ for "2d candidate advantage" $\in \{0, .05, .1\}$. Otherwise $\hat{j}_x$ has values similar to those shown in Figure 2 for the disadvantaged candidate and values slightly higher than those shown for the advantaged candidate.

between the real and the simulated $\hat{j}_x$ curves is not perfect, but the qualitative similarity between the estimated and simulated $\hat{j}_x$ values is striking. The diagnosis is that the losing candidates seem not to attract a lot of strategically switched support.

In Figure 35(b) estimates $\hat{j}_x$ for ridings where Reform party candidates finished second are essentially the same as for the losing Liberal party candidates in Figure 35(a) for $-.175 < -\mathfrak{M}_{23} < 0$, but for $-\mathfrak{M}_{23} < -.175$ the decline in $\hat{j}_x$ continues in Figure 35(a) but not in Figure 35(b). The ridings where a Reform party candidate finished second to a Liberal party candidate with such $-\mathfrak{M}_{23}$ values are however sparse, and when confidence intervals are considered the disparity in $\hat{j}_x$ between Figures 35(a,b) is not that great. So the best approach is to focus on the similarities between the estimates and conclude that the losing Reform party candidates also did not attract substantial strategically switched support.

Estimates of $\hat{j}_x$ for other parties using 1997 data have patterns that also match the symmetric simulation and Figures 2(a,b), but there are some differences. Figures 35(c,d) show $\hat{j}_x$ based on vote counts for the Liberal party and the Progressive Conservative (PC) party, respectively, using ridings where these two parties finished first and second. Figure 35(c) is very similar to Figure 35(a), except the range of $\mathfrak{M}_{13}$ values in Figure 35(c) is slightly wider than in Figure 35(a). $\hat{j}_x$ rises to greater values in Figure 35(c) than in Figure 35(a) for the greater values of $\mathfrak{M}_{13}$—$\mathfrak{M}_{13} > .5$—that occur in Figure 35(c). Figure 35(d) is very similar to Figure 35(b) in ridings where the respective parties won. Figures 35(d) and 35(b) differ in ridings where the respective parties finished second. In Figure 35(d) $\hat{j}_x$ continues to decline as $-\mathfrak{M}_{23}$ decreases, while in Figure 35(b) for similar values of $\mathfrak{M}_{23}$ $\hat{j}_x$ stops declining and becomes statistically indistinguishable from $\bar{j}$. These values of $\hat{j}_x$ in Figure 35(d) are similar to those in Figure 35(c), except that in Figure 35(d) $\hat{j}_x$ is well above $\bar{j}$ (for $-\mathfrak{M}_{23} \approx 0$) before it declines as $-\mathfrak{M}_{23}$ decreases, while in Figure 35(c) $\hat{j}_x$ never differs significantly from $\bar{j}$. $\hat{j}_x$ in Figure 35(c) also declines significantly below $\bar{j}$. Probably these differences should not affect the interpretation that the losing party tended not to receive many strategically switched votes.

In ridings where the Liberal party and NDP were in first and second place, the patterns in $\hat{j}_x$ are similar to those observed for other parties and again suggest there were strategically added votes for winners but not for losers. The patterns for the Liberal party, in Figure 35(e), resemble Figure 35(c). Figure 35(f), for NDP, resembles Figure 35(d) in ridings where NDP was in second place. The reason $\hat{j}_x$ does not increase for the highest values of $\mathfrak{M}_{13}$ in Figure 35(f) is probably because the observed values of $\mathfrak{M}_{13}$ have a lower upper bound in Figure 35(f) than in Figures 35(a–e). Otherwise it seems similar.

The patterns in $\hat{j}_x$ in ridings where other pairs of parties finished in first and second place are also similar to the patterns in Figure 35. Figure 36 shows $\hat{j}_x$ for ridings in which Reform is paired with, respectively, the PC party and NDP. These ridings are fewer and so the data are sparser, with the result that sometimes $\hat{j}_x$ varies over covariate domains that have no observed data.[86] Ignoring these unsupported variations, $\hat{j}_x$ decreases for winners as $\mathfrak{M}_{13}$ increases above zero, then $\hat{j}_x$ starts to increase as $\mathfrak{M}_{13}$ grows through $\mathfrak{M}_{13} \approx .35$ (Figure 36(a)). For second-place candidates, $\hat{j}_x$ is above $\bar{j}$ when $-\mathfrak{M}_{23}$ is just less than zero

[86]For example, noticeable nonlinear variation in $\hat{j}_x$ that is unsupported by observed data is apparent where $-.18 < -\mathfrak{M}_{23} < 0$ or $0 < \mathfrak{M}_{13} < .14$ in Figure 36(a), and where $0 < \mathfrak{M}_{13} < .17$ in Figure 36(b).

(clearly in Figure 36(b)). $\hat{j}_x$ for second-place candidates is not significantly different from $\bar{j}$ for Reform party candidates in Reform-NDP pair ridings, and for NDP candidates it is barely different. $\hat{j}_x$ for these NDP candidates never differs significantly from 4.35, the value of $\hat{j}$ observed in the asymmetric simulation when there is strategic vote switching (Table 1), which may indicate that these losing candidates received strategically switched votes. Or it may be that $-\mathfrak{M}_{23}$ is not sufficiently negative for the decrease in $\hat{j}_x$ as a function of it to be noticeable.

*** Figure 36 about here ***

Similar patterns are again observed when the Bloc Québécois is considered, with one important difference. Figure 37 shows $\hat{j}_x$ for ridings in which the Bloc Québécois (BQ) is paired in either first or second place with, respectively, the Liberal or the PC parties. The difference from the situation with other parties is apparent in the estimates of $\hat{j}_x$ for the ridings in which the Liberal party and the BQ were first and second, Figures 37(a,b). $\hat{j}_x$ for the Liberal party, in Figure 37(a), resembles the displays of $\hat{j}_x$ in Figure 35, but $\hat{j}_x$ for the BQ, in Figure 37(b), has a similar appearance only for winning candidates. In both Figure 37(a) and 37(b), $\hat{j}_x$ first decreases as $\mathfrak{M}_{13}$ increases, then $\hat{j}_x$ increases as $\mathfrak{M}_{13}$ continues to increase. This is the pattern interpreted as occurring when the winning candidate is attracting strategically switched votes. In ridings where the Liberal party candidate was second, $\hat{j}_x$ starts above $\bar{j}$ and decreases below it as $-\mathfrak{M}_{23}$ decreases. This is the pattern interpreted as occurring when the losing candidate is not attracting strategically switched votes. But $\hat{j}_x$ in ridings where the BQ candidate was second has a pattern of increasing as $-\mathfrak{M}_{23}$ decreases and then again decreasing, but $\hat{j}_x$ never exceeds $\bar{j}$. $\hat{j}_x$ among BQ candidate losers has a maximum value in Figure 37(b) of about $\hat{j}_x \approx 3.9$ for $-\mathfrak{M}_{23} \approx -.08$. This pattern resembles $\hat{j}_x$ as simulated for the disadvantaged party in Figure 2(b), namely the simulation in which there is strategic vote switching, except $\hat{j}_x$ has a lower minimum value in Figure 37(b)—$\hat{j}_x \approx 3.5$ for $-\mathfrak{M}_{23} \approx -.36*$—than in Figure 2(b). It seems candidates of the BQ party attracted strategically switched votes both when they won and when they lost.

*** Figure 37 about here ***

Ridings in which the PC party and the BQ finished first and second are sparse, but the estimates shown in Figures 37(c,d) do not contradict the interpretation that both winning and second-place BQ candidates were receiving strategically switched votes. In Figure 37(d), $\hat{j}_x$ is less than $\bar{j}$ and decreases as $\mathfrak{M}_{13}$ increases, and $\hat{j}_x$ is always less than 4.0 with an apparently parabolic variation as $-\mathfrak{M}_{23}$ decreases. For PC party winners $\hat{j}_x$ in Figure 37(c) has a pattern not incompatible with the pattern in say, Figure 37(a), which would suggest strategically switched gains for winners. Second-place PC candidates are too sparse to produce interpretabl $\hat{j}_x$ estimates.

The patterns in $\hat{j}_x$ displayed in Figures 35–37 explain—at least for 1997—why typically $\hat{j} < \bar{j}$ in Table 6. Such a mean occurs when a party wins while gaining strategically switched votes in a manner more or less well represented by the symmetric simulation in Mebane (2012), and it also often occurs when a party finishes in second place without substantial strategic support, in line with the asymmetric simulation. Values of $\hat{j} < \bar{j}$ also when the second place party does gain strategically switched votes in a manner represented by the symmetric simulation, as is the case for the Bloc Québécois.

Why the symmetric simulation matches the situation where winners gain strategic votes from supporters of, presumably, many small parties requires further investigation. Recall that the match of the simulation to the reality was not perfect. The real $\hat{j}_x$ decreases then increases with increasing $\mathfrak{M}_{13}$,[87] but the simulated $\hat{j}_x$ simply decreases as "2d candidate advantage" increases. Why $\hat{j}_x$ for the second place party matches the asymmetric simulation is more immediately understood: the second place party typically has an asymmetrically small share of support in the riding. The francophone character of the Bloc Québécois likely explains why it, exceptionally, attracts strategically switched votes even when its candidate is not winning: in 1997, at least, the concerns that led to the 1995 referendum over Quebec sovereignty remained unresolved (Howe 1998; Nevitte, Blais, Gidengil and Nadeau 2000, 118–120).

It is a behaviorally contingent point that voters do not usually rally strategically to support the first losing party. Why Canadian voters behave this way remains a question. But such a finding is compatible with the result in Table 17 that often $N_p > 2$, as well as with Chhibber and Kollman's (2004) similar results.[88]

Qualitatively similar patterns generally appear in data from each Candian federal election up through 2011. All told throughout the Canadian elections of 1997–2011, the most frequent pattern suggested by $\hat{j}_x$ is one in which winning candidates attract strategically switched votes while candidates who finish in second place do not. In several elections there are exceptional situations where the second-place finishers do seem to have been receiving strategically switched votes. These include Bloc Québécois candidates in 1997 and may include Conservative party candidates in Quebec in 2008 and Liberal party candidates in 2011 and in 2008 in ridings where the NDP candidate won. Two of these cases represents exceptional circumstances: persistent separatist concerns in the case of the Bloc Québécois; and a looming existential threat in the case of the Liberal party.[89] In all the election years as was the case in 1997, finding that winners attract strategically switched votes while second-place candidates tend not to do so is compatible with the result in Table 17 that often $N_p > 2$.

The simulations from Mebane (2012) that I have relied on to understand the patterns in the conditional digit means do not precisely match the patterns frequently observed for $\hat{j}_x$ in the Canadian polling station data. The match between the digits in losing candidates' vote counts and the nonstrategic simulation—the match to Figure 2(a)—is qualitively sharp if not quantitatively precise: $\hat{j}_x$ computed from the real data does frequently start

[87] Real $\hat{j}_x$ also decreases then increases with increasing $\mathfrak{M}_{12}$.

[88] The distribution of $-\mathfrak{M}_{23}$ values observed in Figures 35–37 is also consistent with the non-bimodal SF ratio (Cox 1994, 613) distribution Chhibber and Kollman (2004, Figure 2.8) find for Canada, although values of the ratio are typically higher than in Chhibber and Kollman's results. In 1997 the SF ratio has mean .68, median .71, first quartile .55 and third quartile .85. For 2000 the distribution is almost the same as in Chhibber and Kollman's Figure 2.8 (for 1935–1997 data): mean .50, median .48, first quartile .28 and third quartile .72.

[89] Ridings in which the Bloc Québécois finished first or second in 2011 are too scarce to support estimating $\hat{j}_x$.

above $\bar{j}$ then drops below $\bar{j}$ as the margin variable increases. This match occurs even though to compute the real-data $\hat{j}_x$ I use $\mathfrak{M}_{23}$ as the covariate instead of a function of the margin between the two leading candidates.

For winning candidates the match with the symmetric simulation and Figure 2(b) is not as good, even qualitatively. In the real data $\hat{j}_x$ first decreases as the margin increases, as in the simulation, but then frequently the real-data $\hat{j}_x$ increases as the margin continues to increase. This difference between real and simulated $\hat{j}_x$ is not because different margins are being used in the two calculations: very similar patterns occur in the real data when $\mathfrak{M}_{12}$ is used as the covariate instead of $\mathfrak{M}_{13}$. Instead I conjecture the difference has to do with many parties existing in Canada while in the simulation that produces Figure 2(b) the simulated voters choose among only three parties. It may be that $\mathfrak{M}_{13}$ getting large is an indication that something like the asymmetric pattern in the digits comes into effect. For some winning candidates in every year, $\hat{j}_x$ does rise to $\hat{j}_x \approx 4.35$ or even higher values (see Figures 35(c,e), 36(d) and 37(a)).

The highest values of $\hat{j}_x$ for winning candidates are similar to the values frequently observed at high margins (or high $\mathfrak{D}_k$ values) for parties in the data from Germany. There is no evidence to believe there is coalition-aware voting in Canada as there is in Germany, but the high values of $\hat{j}_x$ (and $\hat{j}_{xy}$) apparent in both countries suggest that the conditional digit means have properties when there are multiple parties that the (essentially) three-candidate simulations I have created do not fully capture.

6 Mexico

Federal elections in Mexico since 1994 have been closely contested with both volatility in outcomes and frequent charges that election fraud was widespread. Fraud occurred in the presidential election of 1988 (Castañeda 2000, 80–87, 199; Magaloni 2006, 5), although whether the fraud padded the winning share to exceed 50 percent or was necessary to secure a win at all is unclear (Castañeda 2000, 231–239) . Allegations of fraud and postelection protests followed the elections especially of 1994 (McCann and Domínguez 1998), 2006 (Klesner 2007; López 2009) and 2012 (Sala Superior 2012*a*,*b*; Sandels 2012), although in these cases it is less clear whether substantial fraud actually occurred. In the later elections fraud allegations concerned charges of vote buying and campaign media irregularities more than of ballot box stuffing or simple faked vote counts.

Many parties have contested Mexican federal elections since 1994.[90] Over time in the presidential elections fewer coalitions stand for election. In Table 19, which reports the number of votes for *Presidente* received by each party in each election, one can see that the number of presidential alternatives decreases from nine in 1994 to four in 2012. In each election, however, the top three parties or coalitions receive at least six times the number of votes that other parties or coalitions received. Despite the decrease in the manifest number of parties and coalitions over time, the effective number of parties tends to increase over time. N_p rises from 2.25 in 1994 through 2.52 and 2.96 in 2000 and 2006 to 2.75 in 2012.

[90]Note 13 on page 5 lists the names of all the parties and coalitions that appeared on ballots for the federal offices of *Presidente* or *Diputados Federales* in elections during 1994–2012. These are the parties and coalitions shown as having votes in Instituto Federal Electoral (2007*a*,*b*, 2006, 2012*d*).

*** Table 19 about here ***

The trend in the number of parties and coalitions contesting elections for *Diputados Federales* is the same as that for *Presidente*, except there are more parties and coalitions running for *Diputados* than for *Presidente* in 2012. As shown in Table 20, in each of the elections during 1994–2012 over the whole electorate the top three parties or coalitions receive more than six times the number of votes received by each of the remaining parties.[91] Similar ratios occur among district medians, also reported in Table 20. The effective number of parties, evaluated on a district-specific basis, tends to increase from 1994 to 2012. As shown in Figure 38, the median of N_p over districts in each year increases from 2.18 and 2.23 in 1994 and 2000 up to 2.59 and 2.55 in 2006 and 2012. N_p in these *Mayoría Relativa* (plurality rule) election districts is similar to N_p in the plurality rule elections in Canada (recall Table 17 on page 118).

*** Table 20 and Figure 38 about here ***

As Table 19 reports, election outcomes over time are somewhat volatile. For *Presidente*, PRI wins in 1994 and 2012 (formally as part of CM) while PAN wins in 2000 (formally as part of CAC) and 2006. Table 20 shows that, in terms of overall votes cast, outomes in elections for *Diputados Federales* are similar.

Notwithstanding the volatility in outcomes, the strategies Mexican voters are using feature remarkable stability over time when the strategies are assessed using the digits in polling station vote counts. While the party or coalition that is the target of the strategies changes over time, the mix of strategic patterns apparent over different parties is relatively constant over time.

Estimating $\hat{j}$ for the parties and coalitions contesting the presidential election shows that often $\hat{j} \geq \bar{j}$ for parties and coalitions that finish in one of the top three positions, but $\hat{j} < \bar{j}$ for parties that finished well out of the top three. In instances where tests fail to reject the simple 2BL hypothesis in Tables 7 and 8, the corresponding confidence interval for $\hat{j}$ includes or just barely excludes $\bar{j}$. For the winning party or coalition in each election and for the second-place party in 1994, 2000 and 2006, $\hat{j} > \bar{j}$. These unconditional $\hat{j}$ statistics relate to each party's fate in the election.

Using data from the *Diputados Federales* elections to estimate $\hat{j}$ shows that for these elections the relationship between $\hat{j}$ and $\bar{j}$ does not depend as strongly on the overall share of votes received by a party or coalition, but again $\hat{j}$ does not differ from $\bar{j}$ in instances where tests based on χ^2_{2BL} fail to reject the simple 2BL hypothesis. In 2006, for instance, $\hat{j}$ for NA is the same as $\hat{j}$ for APM even though overall APM received more than six times as many votes as NA. A difference, of course, is that elections for *Diputados Federales* occur in districts while the outcome for *Presidente* depends on votes cast throughout the country. So a party may be competitive for *Diputados Federales* in several districts while receiving only a small share of the overall vote. In fact, based on the *Mayoría Relativa* district vote

[91] Note that in 2012 the presence of a CM candidate in a district means there are not separate PRI or PVEM candidates in the district. Votes are counted for CM whenever there is a positive vote count for "`PRI_PVEM`" in any *secciòn* in a district in the data in Instituto Federal Electoral (2012*d*). When no such positive vote total is observed, the votes reported for "`PRI`" and for "`PVEM`" are counted separately.

only the top three parties in overall vote count in each year shown in Table 20 won seats in 1994, 2000 and 2006, while every party except NA won seats on this basis in 2012 (Foweraker and Landman 1995; Klesner 2002, 2007; Camara de Diputados 2012). More parties—including NA—did win seats but through the proportional representation rule that also applies to the votes in Mexico's mixed system. From a strategic point of view, the statistics in Tables 7 and 8 therefore suggest that sometimes $\hat{j}$ for the *Diputados Federales* vote counts are affected by proportional representation considerations—as in the case of NA in 2006—and sometimes it is not. As was the case for votes for *Presidente*, $\hat{j} \geq \bar{j}$ for the top three parties or coalitions for *Diputados Federales* in each year, except for APM in 2006.

6.1 Strategies in Elections for *Diputados Federales*

The unconditional $\hat{j}$ values do not give any direct insight into strategies voters may have been using. To understand these strategies, I turn to the conditional means $\hat{j}_x$. Even though Mexico's mixed electoral system undermines the relevance of the kind of wasted vote logic that may apply with a simple plurality system, the margin between candidates can nonetheless be a useful covariate. One might think about using margins between candidates in votes cast in the senate elections, as a kind of possibly more sincere expression of support for parties than *Diputados Federales* votes may be. Based on the proportional representation rules in effect in the senate elections, the justification for such a choice might be analogous to the rationale for similar methods in Germany.[92] Unfortunately for any such plan, senate elections in Mexico do not follow simple proportional representation rules: the proportional rules are combined with state-level plurality rules with a district magnitude of 3.[93] In fact there is little reason to think votes in states for *Senadores* are any more devoid of strategic adjustments than votes in districts are for *Diputados Federales*.

Therefore to estimate $\hat{j}_x$ for *secciòn*-level *Diputados Federales* votes I focus on the *Mayoría Relativa* plurality rule and use for the covariate the margin between each of the two leading parties in each district and the party that is in third place in the district ($\mathfrak{M}_{13}$ and $\mathfrak{M}_{23}$). Figure 39 is an example of such estimation using *Diputados Federales* in 1994. The figure shows results for districts in which PRI and PAN finished in first and second place. Figure 39(a) displays $\hat{j}_x$ (conditional district means) based on the second digits of *secciòn* votes for PRI. $\hat{j}_x$ for districts where PRI won and PAN was second is plotted for positive values of the x-axis, and for these estimates the covariate is $\mathfrak{M}_{13}$. $\hat{j}_x$ for districts where PRI was second and PAN won is plotted for negative values of the x-axis, and for these estimates the covariate is $-\mathfrak{M}_{23}$. Figure 39(b) displays the analogously estimated $\hat{j}_x$ based on votes for PAN.

*** Figure 39 about here ***

[92]See page 19.

[93]In each of the 32 states the party with the most votes wins two seats and the party with second-most votes wins one seat. The remaining 32 seats are awarded on a national basis by proportional representation (Instituto Federal Electoral 2012*f*).

In 1994 $\hat{j}_x$ reveals a clear distinction between the votes received for *Diputados Federales* by the two leading parties: both parties seems to have benefitted from strategically switched votes in districts that each won, but there is no evidence that PAN received strategically switched votes in districts in which it finished in second place. The evidence for the first part of this interpretation is the fact that in Figure 39(a) in districts where PRI won $\hat{j}_x$ is not only always greater than $\bar{j}$ but in fact is never significantly different from the value $\hat{j}_x \approx 4.35$ seen for a party in Table 1—summarizing the three-party asymmetric simulation—in situations where the party received strategically switched votes. In Figure 39(b) $\hat{j}_x$ for PAN is not signifcantly different from 4.35 except $\hat{j}_x$ rises significantly above 4.35 for $\mathfrak{M}_{13} > .4$. The fact that $\hat{j}_x$ mostly does not differ significantly from the value 4.35 for either party in districts where the party won suggests that both parties attracted strategically switched votes in those situations. The lack of strategically switched votes for second-place PAN candidates is evidenced by the fact that, in Figure 39(b), $\hat{j}_x$ is never significantly different from $\bar{j}$ in districts where PAN was second. Of course from this evidence the meaning of "strategic" behavior in these elections cannot be pinned down in substantive political terms. Perhaps it refers to the kinds of policy and performance considerations that McCann and Domínguez (1998) examine, or it may point to the kind of vote buying through manipulating federal programs that Magaloni (2006, 122–150) documents.[94] Instead of "strategically switched" votes perhaps it would be better to refer more generally to "especially mobilized" votes.

The 2000 elections for *Diputados Federales* show many similarities with 1994 in the patterns in $\hat{j}_x$ for the votes received by PRI and PAN candidates. PAN in the 2000 elections joined with PVEM to form the coalition CAC. CAC in 2000 narrowly edged out PRI to win the most votes overall, while in 1994 PRI had received nearly twice as many votes as PAN (see Table 20). For the most part $\hat{j}_x$ for CAC does not differ significantly from 4.35 in districts where CAC finished first and PRI was second (Figure 40(a)), except $\hat{j}_x$ very slightly but significantly exceeds 4.35 when $.19 < \mathfrak{M}_{13} < .50$ (the average of $\hat{j}_x$ over this range is 4.38). $\hat{j}_x$ for PRI in districts where PRI won (Figure 40(b)) does not differ significantly from 4.35 for $\mathfrak{M}_{13} < .2$, although $\hat{j}_x$ is significantly below 4.35 when $\mathfrak{M}_{13} > .2$, decreasing as $\mathfrak{M}_{13}$ increases to become indistinguishable from $\bar{j}$ when $\mathfrak{M}_{13} > .47$. Compared to 1994, the zone in which second-place PRI candidates benefitted from strategically switched votes versus PAN seems to have narrowed in 2000. In districts where CAC finished second and PRI won, $\hat{j}_x$ for CAC is significantly greater than $\bar{j}$ for $-\mathfrak{M}_{23}$ very near zero and for $-\mathfrak{M}_{23} < -.22$ but not for intermediate $\mathfrak{M}_{23}$ values. As $-\mathfrak{M}_{23}$ decreases $\hat{j}_x$ does not significantly exceed $\bar{j}$ in these districts until $-\mathfrak{M}_{23} < -.33$. Perhaps in the districts where $\mathfrak{M}_{23}$ is large one can read a signal of CAC gaining especially mobilized votes, but in general no such signal is present. In districts where PRI finished second to CAC, $\hat{j}_x$ for PRI is significantly greater than $\bar{j}$ when $-\mathfrak{M}_{23} < -.11$, and $\hat{j}_x$ is not significantly different from 4.35 when $-\mathfrak{M}_{23} < -.22$ but is significantly less than 4.35 for smaller values of $\mathfrak{M}_{23}$. In 2000 compared to 1994 both parties seem to gain substantially less from strategically switched votes in districts where they finished second to one another. On the whole the patterns in $\hat{j}_x$ in districts where CAC and PRI were the leading parties are similar to the patterns in 1994 except that in 2000 PAN (as part of the CAC coalition)

[94]Magaloni (2006) argues that policy and performance judgments also affected votes.

received many more votes than in 1994.

*** Figure 40 about here ***

In 2000 the coalition CAM finished a strong third in the *Diputados Federales* elections, receiving almost half as many votes overall as the leading coalition CAC (see Table 20). $\hat{j}_x$ for districts in which CAC and CAM finished first and second (Figures 40(c,d)) suggest both coalitions received strategically switched votes both when they won and when they lost. $\hat{j}_x$ for these coalitions in these districts is never significantly less than 4.35. $\hat{j}_x$ is significantly above 4.35 for CAC in districts where CAC finished first and $\mathfrak{M}_{13} > .14$ or in districts where CAC finished second and $-\mathfrak{M}_{23} < -.13$, and for CAM in districts where CAM finished first and $.14 < \mathfrak{M}_{13}$. Perhaps the appearance of comprehensive strategically switched vote gains in these districts is a consequence of having two coalitions of parties in the lead. $\hat{j}_x$ in 2000 in districts where PRI and CAM finished first and second (Figures 40(e,f)) suggests that neither party in these races received strategically switched votes. $\hat{j}_x$ does not differ significantly from $\bar{j}$ for either party, except when $.26 < \mathfrak{M}_{13} < .37$ for PRI and when $.1 < \mathfrak{M}_{13} < .34$ for CAM. The patterns in $\hat{j}_x$ where each party was first resemble the patterns in Figure 1(b) from the simulation in which there is turnout decline but no strategic vote switching.

Signs of strategic behavior are even less prevalent in *Diputados Federales* elections of 2006 than in 2000. In 2006 the PRI and PVEM parties ran candidates as the coalition APM. $\hat{j}_x$ takes values that suggest there is strategic vote switching to PAN when it wins against a second-place APM (Figure 41(a)): $\hat{j}_x$ does not differ significantly from 4.35 for $\mathfrak{M}_{13} > .4$, but for smaller values of $\mathfrak{M}_{13}$ $\hat{j}_x$ is not all that different from 4.35.[95] In districts where PAN defeated PBT in second place (Figure 41(c)), PAN also seems to have gained strategically switched votes: $\hat{j}_x$ is never substantially different from 4.35.[96] These $\hat{j}_x$ values may suggest that PAN tended to receive strategically switched votes in districts where it won, but the values of $\hat{j}_x$ for PAN in districts where it finished second do not suggest it gained strategically switched votes in those cases. In districts where PAN finished second to APM, $\hat{j}_x$ for PAN is always significantly less than 4.35, and $\hat{j}_x$ is significantly greater than $\bar{j}$ only for $-.11 < -\mathfrak{M}_{23}$. In districts where PAN was second behind PBT, $\hat{j}_x$ is significantly greater than $\bar{j}$ only for $-\mathfrak{M}_{23} < -.1$.

*** Figure 41 about here ***

In 2006 PBT candidates seem to have attracted strategically switched votes when they finished first over a PAN candidate in second place, but APM candidates did not. APM in districts where APM and PAN finished first and second seems not to have ever gained strategically switched votes (Figure 41(b)): $\hat{j}_x$ is never significantly different from $\bar{j}$ when APM won; and $\hat{j}_x$ is significantly greater than $\bar{j}$ in districts where APM finished second only for $-.27 < -\mathfrak{M}_{23} < -.15$. The pattern for the districts where APM was second in Figure 41(b) resembles the pattern in Figure 1(b), which is the simulation in which there is

[95]For $\mathfrak{M}_{13} \in [0, .38]$, the average value of the upper bound of the confidence interval of $\hat{j}_x$ is 4.32.

[96]For $\mathfrak{M}_{13} \in [.05, .11]$, the upper bound of the confidence interval of $\hat{j}_x$ is less than 4.35 but its average there is 4.32.

no strategic vote switching. In districts where PBT and PAN finished first and second, $\hat{j}_x$ in districts where PBT was first is pretty much the same as $\hat{j}_x$ where PAN was first (compare $\hat{j}_x$ above the positive parts of the x-axis in Figures 41(d) and 41(a)), which suggests PBT gained strategically switched votes in these districts. But $\hat{j}_x$ in districts where PBT was second is similar to $\hat{j}_x$ in districts where APM was second to PAN (compare $\hat{j}_x$ above the negative parts of the x-axis in Figures 41(d) and 41(b)).

In districts where APM and PBT finished in first and second place in 2006 there is evidence that APM and PBT attracted strategically switched votes only in some cases. In districts where PBT finished first (Figure 41(f)), $\hat{j}_x$ is never substantially different from 4.35.[97] PBT seems to have attracted strategically switched votes in these districts. Where PBT was second $\hat{j}_x$ is never significantly different from $\bar{j}$, which would suggest an absence of strategically switched votes. The same is true in districts where APM won (Figure 41(e)). In districts where APM finished second, $\hat{j}_x$ is greater than $\bar{j}$ only when $-\mathfrak{M}_{23} < -.24$, and $\hat{j}_x$ is also not significantly different from 4.35 for this range of districts. Perhaps this suggests that votes were strategically switched to APM in these districts.

Elections for *Diputados Federales* in 2012 are especially interesting because of the complex mix of coalitions that competed. In particular the PRI and PVEM parties formed the partial coalition CM: CM had candidates in 199 districts, but PRI and PVEM had separate candidates in the other 101 districts (Instituto Federal Electoral 2012*c*, 4–11; Instituto Federal Electoral 2012*b*, 23–30). Several other parties (PRD, PT and Movimiento Ciudadano) formed the coalition MP, which unified on all candidates (Instituto Federal Electoral 2012*a*). Estimating $\hat{j}_x$ suggests that voters' strategies are different when the coalitions are present than when they are absent. When CM together runs a candidate there is evidence of more strategic vote switching than when PRI and PVEM sponsor candidates separately. When CM together runs a candidate there seems to be more strategic vote switching not only for the CM candidate but also for candidates supported by opposing parties and coalitions.

The sensitivity of strategic behavior to the presence of a coalition as opposed to merely the parties comprising the coalition is apparent in races in which MP and CM or PRI were in the lead. In districts where CM and MP finished in first and second place, both coalitions have $\hat{j}_x$ values that are never significantly less than 4.35 (Figures 42(a,b)). In districts where MP won and CM was second, $\hat{j}_x$ is slightly greater than 4.35 for MP when $.27 < \mathfrak{M}_{13} < .42$ and for CM when $-.25 < -\mathfrak{M}_{23} < -.04$. These values are evidence of strategic vote switching adding to the vote totals of both winners and second-place finishers in all the districts where the two coalitions led. In contrast consider the districts in which PRI and MP finished in first and second (Figures 42(c,d)). When PRI is sponsoring candidates not as part of the CM coalition, $\hat{j}_x$ for PRI is never significantly greater than $\bar{j}$ and indeed is somewhat less than $\bar{j}$ in some of the districts where PRI won.[98] $\hat{j}_x$ for MP is frequently less than $\bar{j}$ in districts where MP was second behind a PRI candidate, a condition that never occurred when an MP candidate finished second behind a

[97]For $\mathfrak{M}_{13} \in [.07, .29]$, the upper bound of the confidence interval of $\hat{j}_x$ is less than 4.35 but its average there is 4.30.

[98]$\hat{j}_x$ for PRI in Figure 42(c) is significantly less than $\bar{j}$ when $.15 < \mathfrak{M}_{13} < .22$.

CM candidate.[99] In districts where the MP candidate defeated the second-place PRI candidates, $\hat{\jmath}_x$ for MP rises above 4.35 only when $.21 < \mathfrak{M}_{13}$. Indeed $\hat{\jmath}_x$ for MP in the MP-winning districts resembles $\hat{\jmath}_x$ for the advantaged candidate in Figure 1(a), the simulation with no strategic vote switching and no turnout decline. In any case, evidence based on $\hat{\jmath}_x$ suggesting there is strategic vote switching in favor of the MP candidate when such a candidate is running against a strong PRI candidate is much less than the evidence when an MP candidate is running against a strong CM candidate.

*** Figure 42 about here ***

The sensitivity of strategic behavior to the presence of coalitions is apparent as well in races in which PAN is one of the leading parties. Districts in which PAN and MP finished first and second are relatively few so that the confidence bands for $\hat{\jmath}_x$ are wide (Figures 43(a,b)). $\hat{\jmath}_x$ for both PAN and MP is never significantly less than 4.35 for both winning and second-place candidates. $\hat{\jmath}_x$ for PAN is significantly greater than $\bar{\jmath}$ in all but one of the districts where PAN won, and for that district the point estimate of $\hat{\jmath}_x$ is greater than $\bar{\jmath}$. In districts where MP won, the smallest point estimate of $\hat{\jmath}_x$ for MP is $\hat{\jmath}_x \approx 4.25$ at $\mathfrak{M}_{13} = .13$,[100] and $\hat{\jmath}_x$ rises well above 4.35 as $\mathfrak{M}_{13}$ increases: the greatest value of $\hat{\jmath}_x$ estimated near an observed margin is $\hat{\jmath}_x \approx 4.7$ for $\mathfrak{M}_{13} = .24$. Where PAN finished second behind MP, the lower bound of the confidence region of $\hat{\jmath}_x$ for PAN is less than $\bar{\jmath}$, but at observed $-\mathfrak{M}_{23}$ values the point estimate of $\hat{\jmath}_x$ averages about $\hat{\jmath}_x \approx 4.25$. The lower bound of the confidence region of $\hat{\jmath}_x$ for MP also is less than $\bar{\jmath}$ for MP candidates who finished second. The average of $\hat{\jmath}_x$ point estimates at observed $-\mathfrak{M}_{23}$ values for these candidates is $\hat{\jmath}_x \approx 4.32$. These $\hat{\jmath}_x$ values give some support to the idea that these PAN and MP candidates all gained strategically switched votes.

*** Figure 43 about here ***

Looking at districts where PAN and CM or PRI led shows clearly how strategic behavior varies with the presence of a coalition candidate. A greater number of districts have PAN and CM or PRI in first and second place, so $\hat{\jmath}_x$ estimates for these districts are more precise than were the estimates for districts where PAN and MP led. In districts where PAN and CM were first and second (Figures 43(c,d)), $\hat{\jmath}_x$ for CM is never meaningfully different from 4.35,[101] and $\hat{\jmath}_x$ for PAN is never significantly different from 4.35 for winning PRI candidates. Evidence of strategically switched vote gains is strong in these cases. When PAN finished second behind CM, $\hat{\jmath}_x$ for PAN does not differ significantly from $\bar{\jmath}$ when $-.11 < -\mathfrak{M}_{23}$ and is significantly less than 4.35 when $-.2 < -\mathfrak{M}_{23}$. The mean of the point estimates of $\hat{\jmath}_x$ when $-.2 < -\mathfrak{M}_{23}$ is $\hat{\jmath}_x \approx 4.25$. This is the same average point estimate as was observed in districts where PAN was second to MP, but here the more precise estimates allow the result to be bounded significantly below the value of $\hat{\jmath}_x \approx 4.35$

[99] $\hat{\jmath}_x$ for MP in Figure 42(d) is significantly less than $\bar{\jmath}$ when $-.11 < -\mathfrak{M}_{23}$.

[100] The confidence region for $\hat{\jmath}_x$ for MP in Figure 43(b) includes $\bar{\jmath}$ for the observed margins $\mathfrak{M}_{13} \in \{.03, .13, .15\}$, but the point estimates of $\hat{\jmath}_x$ at these points are always greater than $\bar{\jmath}$.

[101] $\hat{\jmath}_x$ in Figure 43(d) is significanty greater than 4.35 when $.4 < \mathfrak{M}_{13}$: the lower bound of the confidence interval for $\hat{\jmath}_x$ at $\mathfrak{M}_{13} = .42$ is 4.36 and the point estimate for $\hat{\jmath}_x$ is $\hat{\jmath}_x \approx 4.5$.

found in Table 1: probably strategic vote switching can be ruled out for this party in these districts; the results for PAN versus CM cast doubt on the existence of strategically switched gains for second-place PAN candidates versus MP as well. As $-\mathfrak{M}_{23}$ decreases below $-\mathfrak{M}_{23} = -.2$, $\hat{j}_x$ increases to the point that when $-\mathfrak{M}_{23} < -.34$ $\hat{j}_x$ becomes significantly greater than 4.35. Perhaps these values point to some but not all PAN candidates receiving strategically switched votes when finishing behind a CM candidate.

While there is strong evidence that votes were strategically switched when PAN and CM were first and second, there is no comparable evidence of strategic vote switching when PAN and PRI were in first and second place (Figures 43(e,f)). In districts where PAN won, $\hat{j}_x$ is less than $\bar{j}$ or indistinguishable from $\bar{j}$ when $\mathfrak{M}_{13} < .25$, rising as $\mathfrak{M}_{13}$ increases to reach the value $\hat{j}_x \approx 4.48$ when $\mathfrak{M}_{13} \approx .43$. Where PAN finished second behind PRI, $\hat{j}_x$ never differs significantly from $\bar{j}$ and often is significantly less than $\bar{j}$. Such $\hat{j}_x$ values do not suggest much strategic vote switching toward these PAN candidates. The $\hat{j}_x$ values for winning PRI candidates are significantly greater than $\bar{j}$ when $.18 < \mathfrak{M}_{13}$ but not for higher values of $\mathfrak{M}_{13}$. Second-place PRI candidates for most part have $\hat{j}_x$ indistinguishable from $\bar{j}$. Such $\hat{j}_x$ values convey the impression that there was much less strategic vote switching in the districts where PAN and PRI were the leaders than in the districts where PAN and CM were the leaders.

The conditional digit means $\hat{j}_x$ suggest plausible readings of the strategies being used by voters in all the Mexican elections for *Diputados Federales* examined during 1994–2012. I considered only the elections occurring in the same year as elections for *Presidente*, but such coverage is sufficient to reflect the considerable volatility over time in the sets of parties and coalitions competing in the elections. One frequently repeated pattern is that there is more evidence of strategic vote switching when a coalition is in a leading position in a district than when only parties are leading (e.g., CAC and CAM in 2000, PBT in 2006, CM and MP in 2012). There is not always an apparent increase in strategic vote switching when there is a coalition: APM is 2006 is the clear example. Also strategic vote switching is often apparent for a party when it is in a leading position (e.g., PRI in 1994, PAN in 2006).

As noted previously, the meaning of "strategic" behavior in these elections is ambiguous. It may mean that policy considerations motivate many voters to switch votes to one of the top two finishers as in classic wasted vote logic, or it may mean there is vote buying based on program patronage or clientelism. Diaz-Cayeros, Estévez and Magaloni (2012) provide extensive evidence that vote buying using federal programs prevailed through most of this time period. What is not apparent is evidence that suggests votes are widely fraudulent. $\hat{j}_x$ as used in this section would not detect highly localized, isolated and sporadic frauds. But any widespread, systemic fraud, if it occurred, produced *secciòn* vote counts that for the most part support natural political interpretations. A major caveat, of course, is that some consider vote buying of the kind we cannot rule out to be a kind of election fraud (e.g. Sandels 2012).

6.2 Mayors and Elections in 2006

Magaloni (2006) and Diaz-Cayeros, Estévez and Magaloni (2012) argue that municipalities figured centrally in vote buying efforts throughout many changes in the formal structure of Mexican federal programs, and even apart from any vote buying efforts municipalities have organizations and other resources that may be used in political mobilization efforts. For one year, 2006, I have information about the party or coalitional affiliation of the mayor in each municipality.[102] I consider how vote counts and the digits in vote counts vary in relation to the mayor of each municipality.

The 2006 Mexican presidential election was close and highly controversial (European Union 2006; Klesner 2007). Five party coalitions sought votes in the election, and the winning candidate's margin of victory was 0.56 percent. The winner was Felipe Calderón of PAN, and the candidate receiving the second largest number of votes was Andrés Manuel López Obrador of the PBT. Also in the election was NA, formed as a splinter from the longtime ruling party, PRI. Both NA and PRI fielded candidates in the 2006 presidential election. PRI formed the coalition APM with PVEM. The fifth party presenting candidates in the 2006 election for *Presidente* was ASDC.

PAN and PBT filed hundreds of challenges that alleged election day irregularities (European Union 2006, 42–43). The election court did not find irregularities sufficient to change the election outcome (European Union 2006, 3). The principal losing candidate was not persuaded that he had lost fairly (Estrada and Poiré 2007; Schedler 2007). At least one allegation about the election involved possible coercion: there was a claim that NA's leadership instructed teachers' union members in the party to "vote for Nueva Alianza's candidate for senator and 'diputado,' but vote for Calderon for President" (Kelley 2006). Of course this could be no more than a focal statement intended to coordinate strategic voting. For other statistical analysis of fraud allegations in the 2006 election see López (2009).

The official spreadsheet files that report the vote counts for each *casilla* locate each *casilla* in one of 2,422 municipalities (*municipios*). Each municipality may contain several towns and villages, but for the municipality itself there is a government and each such government has an elected mayor. Except in a number of municipalities in the state of Oaxaca, each mayor is affiliated with either a single party or a coalition of parties.[103]

While the mayor has no official role in administering the federal election, the mayor's party coalition likely corresponds to the locally dominant partisan organization. There are many ways such organizational capacity may produce distortions in the election results. For instance, the European Union reports that at some *casillas* "some polling station staff members did not turn up, and had to be replaced by substitutes or voters in line" (European Union 2006, 37). There is a suggestion that in some cases replacements were not haphazard but instead were planned to make sure the polling staff were controlled by one party's supporters (Kelley 2006).

I merge election data from the *Instituto Federal Electoral* (IFE) (Instituto Federal Electoral 2007*c*) with municipality party-affiliation data from *Sistema Nacional de Información Municipal* (SNIM) (Instituto Nacional para el Federalismo y el Desarrollo Municipal 2006).[104] The SNIM data list a party name in cases where the municipality

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[102] I use "mayor" to refer to the municipality president.

[103] According to data from the SNIM (Instituto Nacional para el Federalismo y el Desarrollo Municipal 2006), at the time of the 2006 federal election 421 of the 570 municipalities in Oaxaca had mayors selected via an indigenous method called *uso y costumbre* that does not involve affiliation with a political party. For one discussion of this electoral method, see Eisenstadt (2007).

[104] The party affiliations are listed in a file named `Nueva.dbf` (size 5049961 bytes, timestamp Aug 29, 2006).

mayor is affiliated with a single party, but for 201 of the 2440 municipalities in the file the data indicate only that the mayor is affiliated with a coalition. The SNIM data do not indicate which parties are included in each coalition. The members of each municipality coalition are identified using information organized by CIDAC (Centro de Investigación para el Desarrollo, A.C. 2007), in a few instances supplemented by information from the *Instituto de Mercadotecnia y Opinion* (IMO).[105] Municipality parties align by name with three of the coalitions standing for the federal election, namely PAN, APM and PBT. In some cases members of a municipality's governing coalition align with two federal election coalitions, either PAN and PBT or APM and PBT. Table 21 shows the number of municipality coalitions of each type.

*** Table 21 about here ***

In the election there are separate vote counts for president (*Presidente*), senator (*Senadores*) and deputy (*Diputados Federales*). The Mexican legislature is elected partly using a plurality rule (*Mayoría Relativa*) in single-member districts and partly using proportional representation (*Representación Proporcional*) within five large regional districts. I look only at the *Diputados Federales Mayoría Relativa* results.

Table 22, which shows the number of *secciones* having a vote count greater than 9 for each combination of office, municipality coalition type and party choice, implies that the number of votes for NA and ASDC candidates varies substantially for different offices. Over all kinds of municipality coalitions, NA received many fewer votes for *Presidente* than for *Diputados Federales*, while ASDC received fewer votes for *Diputados Federales* than for *Presidente*. The pattern for NA is in line with the instructions quoted above. Of the other parties, PAN and PBT do better in getting higher vote counts for *Presidente* than for *Diputados Federales*, while APM candidates mostly get more votes for *Diputados Federales*. The exception here is the votes for APM in municipalities with Other coalitions.

*** Table 22 about here ***

Drawing on the simulation results summarized in Table 1 and Figure 2, the $\hat{j}$ values for each candidate and mayor party combination, shown in Table 23, suggest that all these patterns result from strategic vote switching, albeit strategic vote switching that depends on the municipality's partisan configuration. Focus first on the statistics for votes for *Presidente*. Votes for PAN where there is a PAN mayor and votes for PBT where there is a PBT mayor have $\hat{j}$ significantly greater than $\bar{j}$ but not significantly different from the $\hat{j}$ value observed for w_1 in the simulation.[106] The values for $\hat{j}$ for APM are significantly less than $\bar{j}$ in municipalities with PAN or PBT mayors. APM finished second in less than half

Municipalities for IFE and SNIM are not strictly speaking the same administrative units, although usually the geographic borders coincide when the names are the same.

[105]URL `http://www.imocorp.com.mx/`. Phone calls to officials in each municipality were required to resolve contradictions among SNIM, CIDAC and IMO regarding a few municipalities in Coahuila, Chiapas, Sinaloa and Sonora.

[106]I again use "significantly different" to refer to means that differ by more than two standard errors.

of the *secciones* in these municipalities,[107] yet its $\hat{\jmath}$ values in those municipalities are not all that different from the $\hat{\jmath}_x$ values observed for the disadvantaged party in the symmetric simulation with strategic vote switching (see Figure 2(b)). The values for $\hat{\jmath}$ for NA are even smaller than the values for APM in municipalities with PAN or PBT mayors. The $\hat{\jmath}$ values are not as small as $\hat{\jmath}$ is for w_3 in Table 1—recall that w_3 is the vote total for the party simulated as strategically abandoned in the simulation—but the $\hat{\jmath}$ values match values that can be produced in the simulation by slightly increasing the threshold t for the size of differences in preference ratings that govern vote switching in the simulation, so that slightly more voters stick with that third party in the simulation.[108] The pattern suggests there is strategic vote switching in which some voters switch from APM and NA to one of the top two parties in municipalities where there are mayors representing those same top two parties. Votes for ASDC, notably, have $\hat{\jmath}$ values not significantly different from $\bar{\jmath}$. Supporters of ASDC in these municipalities seem not to have switched their votes, and in these municipalities ASDC seems not to have received many strategically switched votes.

*** Table 23 about here ***

The pattern of vote switching in municipalities with other mayoral coalitions differs slightly. Where there is an APM or a PAN-PBT or APM-PBT coalition mayor, $\hat{\jmath}$ for APM, NA and ASDC suggest there is switching away from those choices, but $\hat{\jmath}$ for PAN does not differ significantly from $\bar{\jmath}$. $\hat{\jmath}$ for PBT differs from $\bar{\jmath}$—$\hat{\jmath} < \bar{\jmath}$—only where there is a APM-PBT coalition mayor. Except for PBT with a APM-PBT mayor, these $\hat{\jmath}$ values suggest vote switching from APM, NA and ASDC to PAN and PBT. Where the mayoral coalition is Other, $\hat{\jmath} > \bar{\jmath}$ for PAN, PBT and ASDC, but only the latter two differences are significant, while for NA again significantly $\hat{\jmath} < \bar{\jmath}$. That votes are perhaps switched to one of the top two parties in the presidential election is not surprising, but it is hard to see this for the votes going to ASDC. If that $\hat{\jmath}$ is strategically meaningful, then probably this is a situation analogous to that for y_3 in Table 1: the mere presence of preferentially similar alternatives on the ballot is enough to shift $\hat{\jmath}$ away from $\bar{\jmath}$.

For *Diputados Federales*, $\hat{\jmath}$ values again suggest there was strategic vote switching in favor of PAN and PBT, respectively, in municipalities where each party controlled the mayor's office. In this case the switched votes appear to have come from ASDC and maybe from PBT in races for senator in municipalities with a PAN mayor. In these elections there is no evidence of vote switching away from APM or NA where there are PAN or PBT mayors. $\hat{\jmath}$ is significantly less than $\bar{\jmath}$ for NA candidates with an APM mayor, and there is no indication that another class of candidates received strategically switched votes. Since $\hat{\jmath}$ is in the vicinity of 4.0 here, a reasonable interpretation is probably that this is a case of something like roll-off: NA-preferring voters abstain instead of voting for candidates in places where members of the party they once affiliated with hold sway (recall that NA formed as a splinter from PRI, which is part of APM).

[107] Out of all the *secciones* counted in Table 21, in elections for *Presidente* APM finished second in 7,914 *secciones* in municipalities with a PAN mayor and in 4,150 *secciones* in municipalities with a PBT mayor. In elections for *Diputados Federales* APM finished second in 11,061 *secciones* in municipalities with a PAN mayor and in 4,965 *secciones* in municipalities with a PBT mayor.

[108] If in the simulation $t = .35$, then $\hat{\jmath}$ for w_3 is 3.29. If $t = .5$, then $\hat{\jmath}$ for w_3 is 3.56 and $\hat{\jmath}$ for w_2 is 4.29.

The digit means clearly respond to the affiliation of municipalities' mayors in both elections for *Diputados Federales* and for *Presidente*. The patterns in $\hat{j}$ apparent in Table 23 reflect both a concentration of votes in favor of the two leading parties in the presidential election and more local dynamics in both types of elections. Whatever the basis for the connection between mayors and the $\hat{j}$ statistics, the question of main interest here is whether taking the party of the mayors into account changes the impression—given by Figures 39–42—that $\hat{j}_x$ is informatively a function of the margins $\mathfrak{M}_{13}$ and $\mathfrak{M}_{23}$.

I estimate $\hat{j}_x$, using *secciòn* vote counts, separately for municipalities that have mayors affiliated with each of PAN, PBT or APM. By conditioning $\hat{j}_x$ on the party of the mayor, we can see whether the patterns of dependence between digit means and the margin covariates change when different mayoral parties are considered.

Notice that each district typically contains many municipalities. Table 24 shows the number of, respectively, municipalities, districts and *secciones* for each mayoral party and each combination of district-leading parties. To match the analysis to follow, counts are shown only where the mayor's party is PAN, PBT or APM. Counts are reported separately for the units where each of the leading parties finished in first place. I show results both for the elections for *Diputados Federales* and for the elections for *Presidente*. In Table 24 clearly the number of municipalities counted for each winner always exceeds the number of districts. This means that in parts of a district a candidate may have mayors from the same party while in other parts the mayors may be affiliated with different parties.

*** Table 24 about here ***

First consider the elections for *Diputados Federales*. Figure 44 shows $\hat{j}_x$ estimated using municipalities that had a PAN mayor. The number of *secciones* used to estimate $\hat{j}_x$ is smaller than when all municipalities are used (for which see Figure 41), so the confidence intervals are typically wider in Figure 44. $\hat{j}_x$ using only the municipalities with a PAN mayor differs significantly from $\hat{j}_x$ using all municipalities only in districts where PBT was first ahead of APM with $\mathfrak{M}_{13}$ near $\mathfrak{M}_{13} \approx .4$ (Figure 44(f)). $\hat{j}_x$ is significantly greater than $\bar{j}$ in Figure 41(f) but not in Figure 44(f). This difference suggests that $\hat{j}_x$ conditioned on there being a PAN mayor should differ from $\hat{j}_x$ conditioned on one or more other mayoral parties.

*** Figure 44 about here ***

Indeed comparing $\hat{j}_x$ with a PAN mayor to $\hat{j}_x$ with a PBT mayor (Figure 45) shows significant differences for districts where PAN finished first just ahead of APM and for districts where PBT finished just ahead of APM. To be precise, $\hat{j}_x$ for PAN in districts where PAN was first and APM was second and $\hat{j}_x$ for PBT in districts where PBT was first and APM was second differ significantly depending on whether there was a PAN mayor or a PBT mayor. To see the difference involving PAN, compare Figure 44(a) to Figure 45(a): $\hat{j}_x$ in Figure 44(a) is significantly greater than $\bar{j}$ when $\mathfrak{M}_{13} > .18$, which is not the case in Figure 45(a); $\hat{j}_x$ in Figure 44(a) is significantly greater than $\hat{j}_x$ in Figure 45(a) when $\mathfrak{M}_{13} \approx .34$. The difference involving PBT is evident upen comparing Figure 44(f) to Figure 45(f): $\hat{j}_x$ in Figure 45(f) is significantly greater than $\bar{j}$ (or nearly so) for all $\mathfrak{M}_{13} > 0$, which is not the case in Figure 44(f); $\hat{j}_x$ in Figure 45(a) is significantly greater than $\hat{j}_x$ in Figure 44(a) when $\mathfrak{M}_{13} \approx .38$. The similarity between the differences here is striking. A party's having a mayor seems in a similar way to help votes switch to each party's candidates for *Diputados Federales*, when the candidate wins—if such vote switching is what the relatively high values for $\hat{j}_x$ imply. The suggestion is that the mechanisms by which the party of the mayor is connected to the behavior of voters are similar even when two opposing parties are involved, in distinctive sets of municipalities.

*** Figure 45 about here ***

Significant differences in $\hat{j}_x$ when comparing PAN and PBT mayors are apparent only in districts where PAN or PBT candidates for *Diputados Federales* were leading with APM in second place. $\hat{j}_x$ for PAN or for PBT does not differ depending on the mayor in districts where the two parties were themselves in first and second place (compare Figures 44(c,d) to Figures 45(c,d)), nor when each party was second behind APM (compare Figures 44(a,f) to Figures 45(a,f)). $\hat{j}_x$ for APM never differs depending on whether the mayor is PAN or PBT (compare Figures 44(b,e) to Figures 45(b,e)).

The presence of an APM mayor versus having a mayor of the same party seems to have mattered much more for PBT candidates for *Diputados Federales* than for PAN candidates. When there is an APM mayor, $\hat{j}_x$ for PAN in districts where PAN and APM were first and second (Figure 46(a)) is similar to $\hat{j}_x$ for PAN in comparable districts where there is a PAN mayor (Figure 44(a)). The similarity in that comparison is greater than the similarity in $\hat{j}_x$ for PBT between municipalities with an APM mayor as opposed to a PBT mayor in districts where PBT and APM were first and second: $\hat{j}_x$ for PBT is significantly greater than $\bar{j}$ if there is an APM mayor only where $.21 < \mathfrak{M}_{13} < .39$, while usually $\hat{j}_x > \bar{j}$ if there is a PBT mayor (compare Figure 44(f) to Figure 45(f)). $\hat{j}_x$ for PBT also differs depending on whether the mayor is APM or PBT in districts where PBT and PAN were first and second: with a PBT mayor $\hat{j}_x$ for PBT is significantly greater than $\bar{j}$ when the PBT candidate wins and $.17 < \mathfrak{M}_{13} < .38$ (Figure 45(d)), but $\hat{j}_x$ is never significantly different from $\bar{j}$ for winning PBT candidates with an APM mayor (Figure 46(d)). According to $\hat{j}_x$, PAN candidates seem to have received a similar boost in terms of strategically switched votes regardless of whether the mayor was PAN or APM, while PBT candidates especially benefited from having a PBT mayor in ways they did not from there being an APM mayor.

*** Figure 46 about here ***

Some differences that depend on the mayor's party also appear in $\hat{j}_x$ estimated using votes for *Presidente*. Comparing $\hat{j}_x$ with a PAN mayor to $\hat{j}_x$ with a PBT mayor (Figure 47 versus Figure 48), significant differences occur in districts where PAN and PBT finished first and second and where APM and PBT were leading. In the first case, $\hat{j}_x$ for PAN is significantly greater than $\bar{j}$ in most of the districts where PAN was second and there was a PAN mayor (Figure 47(c)), but where PAN was second and there was a PBT mayor $\hat{j}_x$ is significantly greater than $\bar{j}$ only when $-.17 < -\mathfrak{M}_{23} < -.08$ (Figure 48(c)). The confidence interval for $\hat{j}_x$ when $-\mathfrak{M}_{23} < -.17$ in Figure 48(c) overlaps the confidence interval in Figure 47(c) to a great extent, however, so it is unclear whether the estimates truly convey a different impression of voters' strategies in the presence of the respective mayoral parties. A significant difference is apparent in districts where APM and PBT were first and second: $\hat{j}_x$ is mostly greater than $\bar{j}$ when there is a PBT mayor (Figure 48(f)) but not when there is a PAN mayor (Figure 47(f)). The presence of a PBT mayor seems to add especially mobilized votes to the PBT candidate for *Presidente* in ways that the presence of a PAN mayor does not.

*** Figures 47 and 48 about here ***

Two significant differences in $\hat{j}_x$ are apparent when municipalities that had an APM mayor are compared to places with either PAN or PBT mayors. With a PAN mayor, $\hat{j}_x$ for PAN is significantly greater than $\bar{j}$ in districts where PAN and APM were first and second when $.15 < \mathfrak{M}_{13} < .58$ (Figure 47(a)), but $\hat{j}_x$ never differs significantly from $\bar{j}$ in such districts with an APM mayor (Figure 49(a)). With a PBT mayor, $\hat{j}_x$ for PBT is significantly greater than $\bar{j}$ in districts where APM and PBT were first and second in most instances no matter whether PBT was first or second in the district (Figure 48(e)), but in the same kind of districts with an APM mayor $\hat{j}_x$ does not differ significantly from $\bar{j}$ (Figure 49(e)). Having a PAN mayor helps the PAN candidate gain especially mobilized votes in ways that having an APM mayor does not, and having a PBT mayor helps the PBT candidate gain especially mobilized votes in ways that do not happen with an APM mayor.

*** Figure 49 about here ***

Taking the party of the mayors into account not only changes the way $\hat{j}_x$ is a function of the margins $\mathfrak{M}_{13}$ and $\mathfrak{M}_{23}$, but conditioning on the additional covariate considerably refines the impression of precisely in which circumstances strategic vote switching occurred. The party and coalition that were leading nationally—PAN and PBT—seem to have gained especially in many localities where there was a mayor who was affiliated with the same party or coalition. The especial gains are apparent in districts where PAN or PBT led with APM in either first or second place. The mechanism that produces this pattern is not clear. Similar gains appear to occur both in votes for *Diputados Federales* and in votes for *Presidente*, so the mechanism is not something peculiar to only one kind of office. Differences that depend on the mayor are apparent only for the party and coalition that led nationally in the race for *Presidente*, so the mechanism is not something that operates entirely on a local basis. These mayoral dependencies—and especially the symmetry in the dependencies between PAN and PBT—cannot be explained by simple vote buying in which benefits traceable to the incumbent presidential party attract voters to that party.[109] Whether the dependencies are caused by the mayors or are merely coincident with the mayors is a question.

[109]The complexity observed here may resonate with nuances in the effects on votes estimated by Diaz-Cayeros, Estévez and Magaloni (2012). For example, "In our estimates, only once more than half of the municipality is receiving *Oportunidades* it is predicted to show a positive swing in favor of the PAN" (Diaz-Cayeros, Estévez and Magaloni 2012, 215–216). Perhaps such an incidence of *Oportunidades* beneficiaries correlates with the party of the mayor. Of course, Diaz-Cayeros, Estévez and Magaloni's findings regarding electoral effects of *Oportunidades* cannot explain how PBT-affiliated mayors produced especially mobilized vote gains for PBT candidates.

It is not surprising that the scant evidence brought to bear here leaves the pathway that connects parties' presence and voters' behavior unclear. Further investigation that brings in much more information is warranted, not only information about policy actions (and possible vote buying) but information about how the elections were administered in the localities. One point of such investigation would be to flesh out just what "strategic vote switching" concretely means in this instance. Such investigation would go beyond the purpose of the present discussion, which is merely to show that conditional second-digit distributions—$\hat{j}_x$ and, with the conditioning on the party of the mayor, $\hat{j}$—are interesting diagnostic statistics which can reveal important and subtle features of electoral competition.

7 Discussion

Are the statistics based on the second significant digits of precinct vote counts meaningful? Is the message they help tell about recent (and not so recent) elections plausible?

Mebane (2013) and this paper argue that not only can digit tests help diagnose strategic voting (Mebane 2012) but also they are sensitive to other aspects of normal politics such as kinds of mobilization that go well beyond the scope of strategic voting. So we see what may be effects of especially effective voter mobilization in favor of Democrats in the 2000s in the United States and what may be locally inflected consequences of vote buying in Mexico. We see what seems to be an only-winners-gain pattern of strategic vote switching in Canada. Effects of coalitions are apparent both in Germany and Mexico. Effects of significant sudden shocks (e.g. Fukushima) are also apparent in Germany.

The claim by Pericchi and Torres (2011) that Benford's Law provides a sufficient standard for diagnosing election fraud is almost certainly false, but when considered against the background of more complicated patterns that occur in various electoral settings tests based on the second significant digits of precinct vote counts may be useful for detecting election fraud. Mebane (2010*b*) uses such tests to diagnose likely fraud in Iran's 2009 election. Mebane (2013) compares the Iran 2009 findings to similar statistics for federal elections in Mexico. The Mexican results even more strongly than the discussion above suggest consequences of vote buying, which some (e.g. Sandels 2012) consider election fraud. The analysis becomes extremely intricate however, involving covariates such as the mayoral party affiliation. As Deckert, Myagkov and Ordeshook (2011) and Mebane (2011) argue, it is unlikely that tests based on precinct vote counts' second digits will support simple rules of thumb to diagnose election fraud. Even in Russian elections where tests based on the last digits of turnout figures diagnose fraud (Mebane and Kalinin 2009; Kalinin and Mebane 2011; Myagkov, Ordeshook and Shaikin 2009), the second digits of polling station vote counts provide plausible strategic diagnostics along with some hints of fraud (Mebane and Kalinin 2010).

The fact that digit tests are sensitive to many normal aspects of politics may be good for general political science interests, but it at least complicates the potential for using the tests to diagnose election fraud. The question of whether the patterns in digits produced by fraud differ sharply from the patterns produced by normal politics is not an easy one to answer. Mebane (2013) gives some cases where likely fraud produces very distinctive patterns (such as the Iranian election of 2009 (Mebane 2010*b*), and other elections), but also cases where natural political shocks produce patterns that would otherwise be interpreted as political coercion (for example, the effects of the Fukushima event on elections in Baden-Württemberg). Except in exceptional, flagrant cases, there is no reason to think that forensically diagnosing elections should be any simpler than forensic examinations are in the face of a sophisticated adversary in any other realm.

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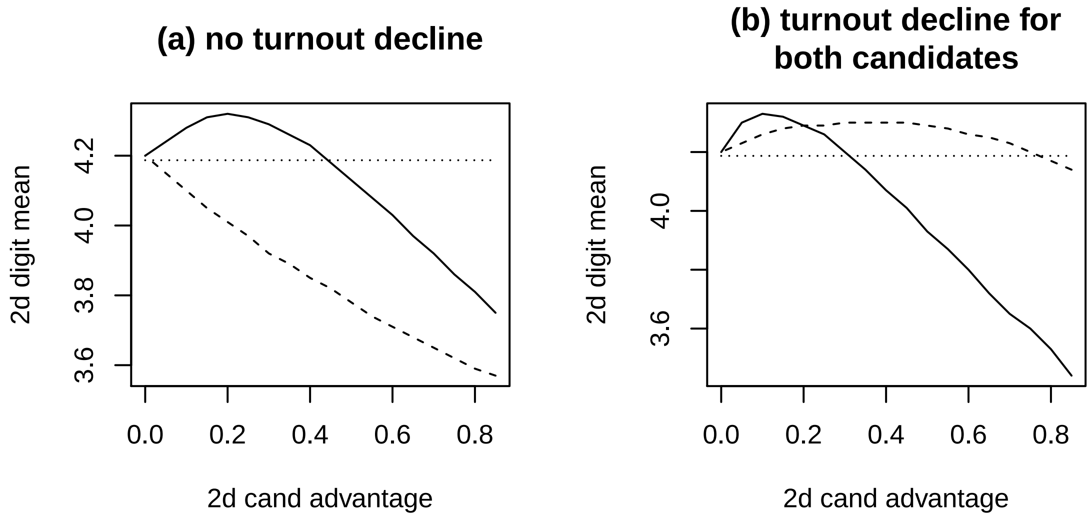
Table 1: Second-digit χ^2_{2BL} statistics, means, standard errors and "vote" totals: asymmetric four-candidate simulation

	y_1	y_2	y_3	y_4	w_1	w_2	w_3	$\tilde{w}_1$
χ^2_{2BL}	10.7	12.6	11.9	12.6	12.3	12.2	951.1	58.0
$\hat{j}$	4.29	4.15	4.32	4.32	4.35	4.35	2.68	3.75
s.e.	.040	.041	.041	.040	.041	.041	.043	.042
votes	$200,284$	$271,628$	$181,172$	$163,970$	$329,043$	$310,300$	$13,741$	$493,013$

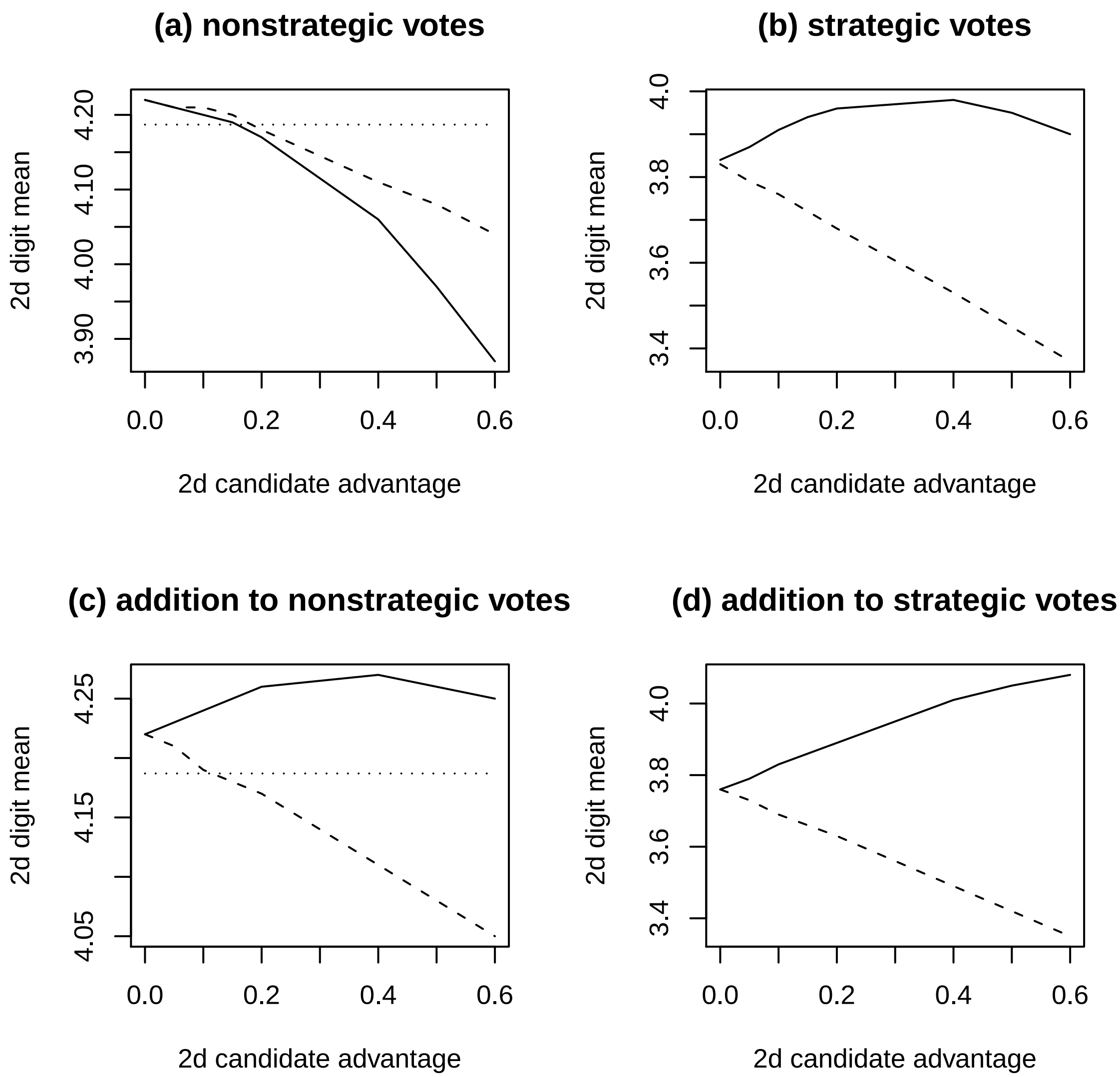
Note: $n = 5000$ precincts. $\mathcal{N} = 1300$, $\sigma = 1$, $v = 1.75$, $t = 0.15$, 500 replications.

Figure 1: Second-digit means by candidate advantage: two-candidate simulation



Note: In rightmost graph, turnout decline factor $= -2$. Solid line is first candidate (disadvantaged). Dashed line is second candidate (advantaged). Dotted line is mean expected under Benford's Law.

Figure 2: Second-digit means by candidate advantage (0 turnout decline factor): symmetric four-candidate simulation including coercion



Note: Solid line is first candidate (disadvantaged). Dashed line is second candidate (advantaged). Dotted line is mean expected under Benford's Law.

Table 2: Second-digit Tests, United States Federal and State Elections, 1984–1990

Year	Office	Party	N	X^2_{2BL}	α	$\hat{j}$	$\hat{j}_{\text{lo}}$	$\hat{j}_{\text{hi}}$
1984	President	Democrat	152,286	135.40	.00	4.21	4.20	4.22
		Republican	152,373	148.34	.00	4.27	4.26	4.29
	U.S. Representative	Democrat	143,659	87.84	.00	4.22	4.21	4.24
		Republican	133,359	112.34	.00	4.24	4.23	4.26
	State House	Democrat	146,221	104.88	.00	4.22	4.20	4.23
		Republican	134,682	98.36	.00	4.23	4.21	4.24
	State Senate	Democrat	73,952	28.50	.02	4.19	4.17	4.21
		Republican	66,066	87.57	.00	4.27	4.25	4.29
1986	U.S. Representative	Democrat	142,660	117.90	.00	4.20	4.19	4.22
		Republican	134,650	101.73	.00	4.20	4.18	4.21
	State House	Democrat	151,116	112.56	.00	4.18	4.16	4.19
		Republican	139,161	68.54	.00	4.20	4.19	4.22
	State Senate	Democrat	82,621	91.37	.00	4.16	4.14	4.18
		Republican	79,993	29.48	.01	4.22	4.20	4.24
1988	President	Democrat	153,330	184.70	0	4.23	4.22	4.24
		Republican	153,353	79.44	0	4.23	4.22	4.25
	U.S. Representative	Democrat	140,013	90.22	0	4.23	4.21	4.24
		Republican	131,817	37.04	0	4.21	4.19	4.22
	State House	Democrat	137,145	68.99	0	4.21	4.20	4.23
		Republican	124,800	63.84	0	4.24	4.22	4.25
	State Senate	Democrat	74,800	73.13	0	4.23	4.21	4.25
		Republican	69,565	50.92	0	4.25	4.23	4.27
1990	U.S. Representative	Democrat	140,976	132.74	0	4.17	4.15	4.18
		Republican	136,928	119.33	0	4.15	4.13	4.16
	State House	Democrat	152,878	162.62	0	4.15	4.14	4.17
		Republican	140,680	95.72	0	4.17	4.16	4.19
	State Senate	Democrat	87,014	104.54	0	4.14	4.12	4.16
		Republican	81,878	53.34	0	4.16	4.14	4.18

Note: Statistics for precinct vote counts. N denotes the number of precincts with ten or more votes for the candidate. $\alpha = (1 + [-ep\log(p)]^{-1})^{-1}$ where p is the p-value of X^2_{2BL}. $\hat{j}_{\text{lo}}$ and $\hat{j}_{\text{hi}}$ are the lower and upper bounds of the 95% confidence interval for $\hat{j}$.
Data source: King et al. (1997).

Table 3: Second-digit Tests, United States Federal and State Elections, 2006–2010

Year	Office	Party	N	X^2_{2BL}	α	$\hat{j}$	$\hat{j}_{\mathrm{lo}}$	$\hat{j}_{\mathrm{hi}}$
2006	U.S. Representative	Democrat	126,563	31.21	.01	4.21	4.20	4.23
		Republican	114,140	5.23	.31	4.18	4.16	4.20
	State House	Democrat	103,501	42.80	.00	4.22	4.20	4.24
		Republican	99,177	13.07	.44	4.18	4.17	4.20
	State Senate	Democrat	63,773	19.52	.18	4.23	4.21	4.26
		Republican	56,608	15.44	.35	4.19	4.16	4.21
2008	President	Democrat	137,427	77.57	.00	4.25	4.23	4.27
		Republican	134,519	20.04	.16	4.20	4.19	4.22
	U.S. Representative	Democrat	135,878	84.75	.00	4.25	4.24	4.27
		Republican	126,228	5.05	.30	4.19	4.17	4.20
	State House	Democrat	120,226	74.69	.00	4.25	4.24	4.27
		Republican	111,637	7.81	.47	4.17	4.16	4.19
	State Senate	Democrat	65,023	77.68	.00	4.28	4.26	4.30
		Republican	61,385	11.83	.48	4.21	4.19	4.23
2010	U.S. Representative	Democrat	89,319	30.23	.01	4.23	4.21	4.25
		Republican	92,402	16.24	.32	4.19	4.17	4.21
	State House	Democrat	73,836	56.38	.00	4.25	4.23	4.27
		Republican	75,826	13.53	.43	4.21	4.19	4.23
	State Senate	Democrat	44,886	39.12	.00	4.26	4.24	4.29
		Republican	45,017	9.65	.50	4.19	4.17	4.22

Note: Statistics for precinct vote counts. N denotes the number of precincts with ten or more votes for the candidate. $\alpha = (1 + [-ep\log(p)]^{-1})^{-1}$ where p is the p-value of X^2_{2BL}. $\hat{j}_{\mathrm{lo}}$ and $\hat{j}_{\mathrm{hi}}$ are the lower and upper bounds of the 95% confidence interval for $\hat{j}$.
Data source: 36 states in 2006, 41 states in 2008, and 29 states in 2010; collected by the author.

Table 4: Second-digit Tests, German Federal Elections, 2002–2009

Type	Party	N	X^2_{2BL}	α	$\hat{j}$	$\hat{j}_{\text{lo}}$	$\hat{j}_{\text{hi}}$
Erststimmen	SPD	264,929	158.45	0	4.24	4.23	4.25
	CDU/CSU	266,731	337.43	0	4.27	4.26	4.29
	FDP	234,416	217.94	0	4.27	4.26	4.28
	PDS/Linke	182,193	158.27	0	4.11	4.09	4.12
	Green	216,109	4.71	.26	4.19	4.18	4.20
Zweitstimmen	SPD	264,529	65.07	0	4.18	4.17	4.19
	CDU/CSU	266,627	175.01	0	4.21	4.20	4.22
	FDP	250,433	69.78	0	4.18	4.17	4.19
	PDS/Linke	190,590	129.52	0	4.11	4.10	4.13
	Green	233,480	35.54	0	4.17	4.16	4.19

Note: Statistics for polling station vote counts. N denotes the number of polling stations with ten or more votes for the candidate. $\alpha = (1 + [-ep\log(p)]^{-1})^{-1}$ where p is the p-value of X^2_{2BL}. $\hat{j}_{\text{lo}}$ and $\hat{j}_{\text{hi}}$ are the lower and upper bounds of the 95% confidence interval for $\hat{j}$. Data source: Bundeswahlleiter (2010*b*,*a*, 2011*b*).

Table 5: Second-digit Tests, Canadian Federal Elections, 1997–2000

Year	Party	N	χ^2_{2BL}	$\hat{\alpha}$	$\hat{j}$	$\hat{j}_{\mathrm{lo}}$	$\hat{j}_{\mathrm{hi}}$
1997	Liberal	56,272	308.4	.00	3.98	3.96	4.00
	Reform/Alliance[a]	38,587	47.6	.00	4.10	4.07	4.13
	Progressive Conservative	50,847	15.7	.34	4.21	4.19	4.24
	NDP	36,128	126.6	.00	4.02	3.99	4.05
	Bloc Québécois	13,956	495.6	.00	3.66	3.61	3.71
	Green Party	899	263.3	.00	2.76	2.59	2.94
2000	Liberal	60,390	666.4	.00	3.91	3.88	3.93
	Reform/Alliance[a]	50,890	151.4	.00	4.04	4.01	4.06
	Progressive Conservative	45,212	101.1	.00	4.06	4.03	4.09
	NDP	32,112	537.1	.00	3.82	3.79	3.85
	Bloc Québécois	14,692	409.3	.00	3.72	3.67	3.76
	Green Party	2,336	588.0	.00	2.79	2.69	2.90

Notes: [a] Reform in 1997, Canadian Alliance in 2000. Statistics for polling station vote counts. N is the number of polling stations with a vote count > 9.
$\alpha = (1 + [-ep\log(p)]^{-1})^{-1}$ where p is the p-value of X^2_{2BL}. $\hat{j}_{\mathrm{lo}}$ and $\hat{j}_{\mathrm{hi}}$ are the lower and upper bounds of the 95% confidence interval for $\hat{j}$.
Data source: Elections Canada (2006*c*).

Table 6: Second-digit Tests, Canadian Federal Elections, 2004–2011

Year	Party	N	X^2_{2BL}	α	$\hat{j}$	$\hat{j}_{\text{lo}}$	$\hat{j}_{\text{hi}}$
2004	Liberal	59,165	163.4	.00	4.06	4.03	4.08
	Conservative	55,105	222.6	.00	4.03	4.00	4.05
	NDP	48,383	7.3	.45	4.18	4.15	4.20
	Bloc Québécois	14,554	247.1	.00	3.83	3.78	3.88
	Green Party	27,864	1700.5	.00	3.50	3.46	3.53
2006	Liberal	59,200	149.5	.00	4.06	4.03	4.08
	Conservative	60,834	176.1	.00	4.06	4.03	4.08
	NDP	55,635	12.2	.47	4.18	4.15	4.20
	Bloc Québécois	15,084	241.1	.00	3.84	3.79	3.88
	Green Party	27,864	1700.5	.00	3.48	3.45	3.51
2008	Liberal	61,541	96.4	.00	4.10	4.07	4.12
	Conservative	64,267	181.6	.00	4.05	4.03	4.07
	NDP	59,944	38.1	.00	4.25	4.23	4.28
	Bloc Québécois	15,719	225.6	.00	3.85	3.81	3.90
	Green Party	37,736	655.3	.00	3.81	3.78	3.84
2011	Liberal	57,377	18.97	.20	4.14	4.12	4.17
	Conservative	66,307	404.73	.00	3.96	3.94	3.99
	NDP	66,791	60.13	.00	4.13	4.11	4.15
	Bloc Québécois	15,717	33.14	.00	4.31	4.26	4.35
	Green Party	19,081	2248.08	.00	3.21	3.17	3.25

Notes: Statistics for polling station vote counts. N is the number of polling stations with a vote count > 9. $\alpha = (1 + [-ep\log(p)]^{-1})^{-1}$ where p is the p-value of X^2_{2BL}. $\hat{j}_{\text{lo}}$ and $\hat{j}_{\text{hi}}$ are the lower and upper bounds of the 95% confidence interval for $\hat{j}$.
Data source: Elections Canada (2006a,b, 2010, 2012).

Table 7: Second-digit Tests, Mexican Federal Elections, 1994 and 2000

Year	Office	Party	N	χ^2_{2BL}	$\hat{\alpha}$	$\hat{j}$	$\hat{j}_{\mathrm{lo}}$	$\hat{j}_{\mathrm{hi}}$
1994	*Presidente*	PAN	55,786	22.91	.08	4.19	4.16	4.21
		PRI	63,199	235.66	.00	4.36	4.33	4.38
		PRD	55,934	23.25	.07	4.16	4.13	4.18
		PVEM	12,318	528.30	.00	3.60	3.55	3.65
		PT	31,003	118.80	.00	4.02	3.99	4.06
		PARM	3,509	609.75	.00	3.05	2.96	3.14
		PPS	2,158	570.03	.00	2.78	2.67	2.90
		PRN	7,955	796.25	.00	3.29	3.23	3.36
		PDM	1,547	146.85	.00	3.33	3.19	3.47
1994	*Diputados*	PAN	55,409	17.60	.26	4.19	4.16	4.21
		PRI	63,191	200.02	.00	4.34	4.32	4.37
		PRD	55,215	24.58	.05	4.15	4.13	4.18
		PVEM	16,637	209.72	.00	3.87	3.83	3.92
		PT	28,467	186.67	.00	3.96	3.92	3.99
		PARM	5,508	779.17	.00	3.13	3.05	3.20
		PPS	4,585	1260.27	.00	2.76	2.68	2.84
		PRN	11,321	814.26	.00	3.43	3.37	3.48
		PDM	2,715	234.38	.00	3.38	3.27	3.48
2000	*Presidente*	CAC	59,545	98.52	.00	4.30	4.28	4.33
		PRI	63,308	132.06	.00	4.29	4.27	4.31
		CAM	58,092	8.38	.49	4.19	4.17	4.21
		PCD	3,937	1254.79	.00	2.63	2.55	2.71
		PARM	1,725	667.27	.00	2.57	2.44	2.69
		DSPPN	21,739	145.43	.00	3.96	3.92	4.00
2000	*Diputados*	CAC	59,071	61.89	.00	4.28	4.25	4.30
		PRI	63,308	131.74	.00	4.28	4.25	4.30
		CAM	58,559	14.00	.41	4.19	4.16	4.21
		PCD	14,640	537.50	.00	3.64	3.59	3.69
		PARM	6,301	1694.15	.00	2.76	2.69	2.82
		DSPPN	21,375	95.05	.00	4.00	3.96	4.04

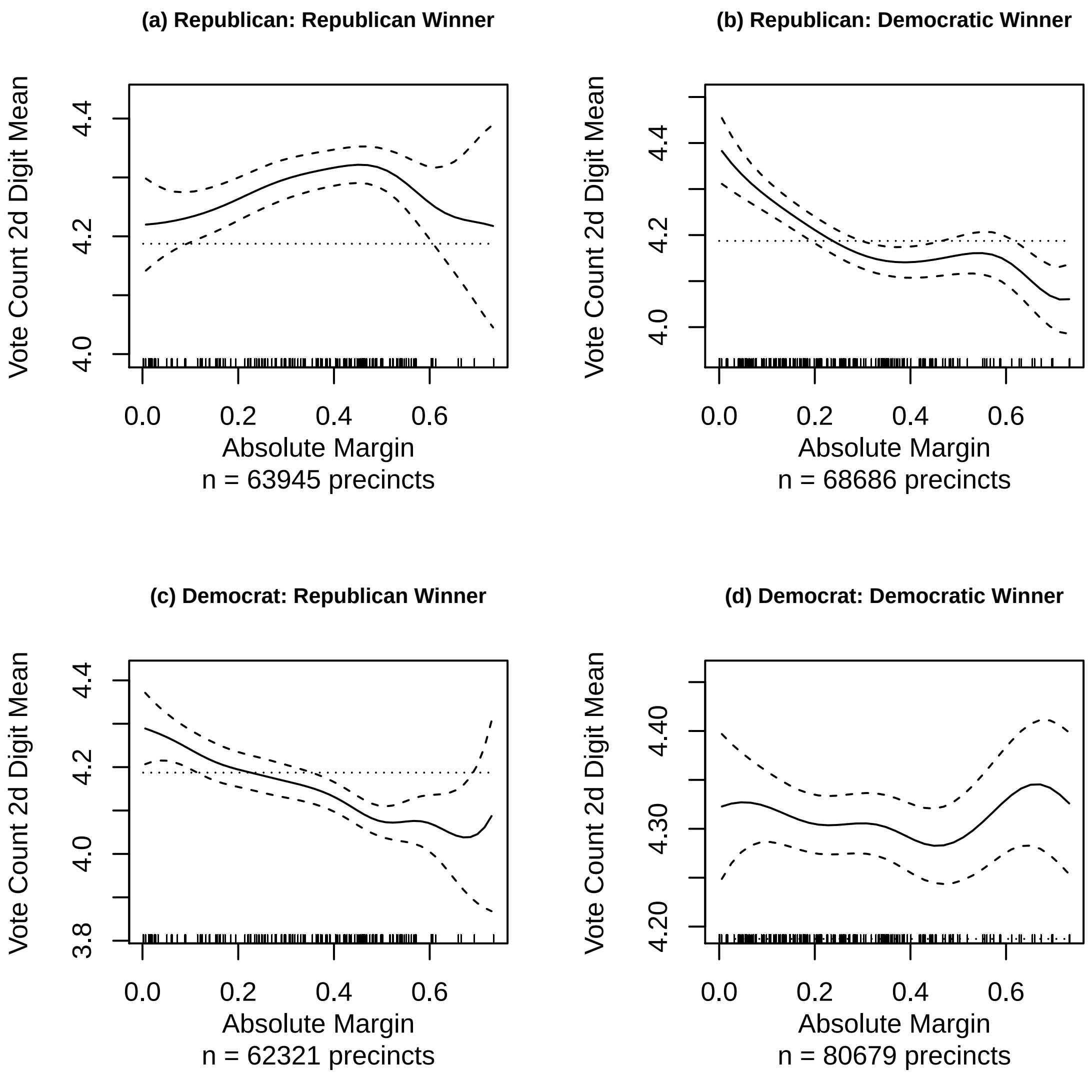
Notes: Statistics for *sección* vote counts. N is the number of *secciones* with a vote count > 9. $\alpha = (1 + [-ep\log(p)]^{-1})^{-1}$ where p is the p-value of X^2_{2BL}. $\hat{j}_{\mathrm{lo}}$ and $\hat{j}_{\mathrm{hi}}$ are the lower and upper bounds of the 95% confidence interval for $\hat{j}$.
Data source: Instituto Federal Electoral (2007*a*,*b*, 2006, 2012*d*).

Table 8: Second-digit Tests, Mexican Federal Elections, 2006 and 2012

Year	Office	Party	N	X^2_{2BL}	α	$\hat{j}$	$\hat{j}_{\mathrm{lo}}$	$\hat{j}_{\mathrm{hi}}$
2006	*Presidente*	PAN	62,490	48.11	.00	4.25	4.23	4.28
		APM	63,915	108.96	.00	4.08	4.05	4.10
		PBT	63,143	25.30	.04	4.24	4.21	4.26
		NA	12,303	1254.78	.00	3.29	3.24	3.34
		ASDC	35,364	16.64	.30	4.15	4.12	4.18
	Diputados	PAN	62,621	34.56	.00	4.23	4.21	4.26
		APM	64,424	36.22	.00	4.14	4.12	4.17
		PBT	62,718	11.35	.49	4.19	4.17	4.21
		NA	43,295	17.57	.26	4.14	4.12	4.17
		ASDC	27,229	234.43	.00	3.92	3.89	3.96
2012	*Presidente*	PAN	65,114	19.36	.19	4.17	4.15	4.19
		CM	66,658	99.24	.00	4.29	4.27	4.32
		MP	64,869	11.34	.49	4.22	4.19	4.24
		NA	38,244	223.56	.00	3.98	3.95	4.00
	Diputados	PAN	64,503	6.46	.41	4.18	4.16	4.20
		PRI	27,361	8.09	.48	4.17	4.13	4.20
		PVEM	15,855	119.23	.00	3.95	3.90	3.99
		NA	47,431	31.31	.01	4.13	4.10	4.15
		CM	39,001	149.04	.00	4.36	4.33	4.39
		MP	63,963	7.57	.46	4.21	4.18	4.23

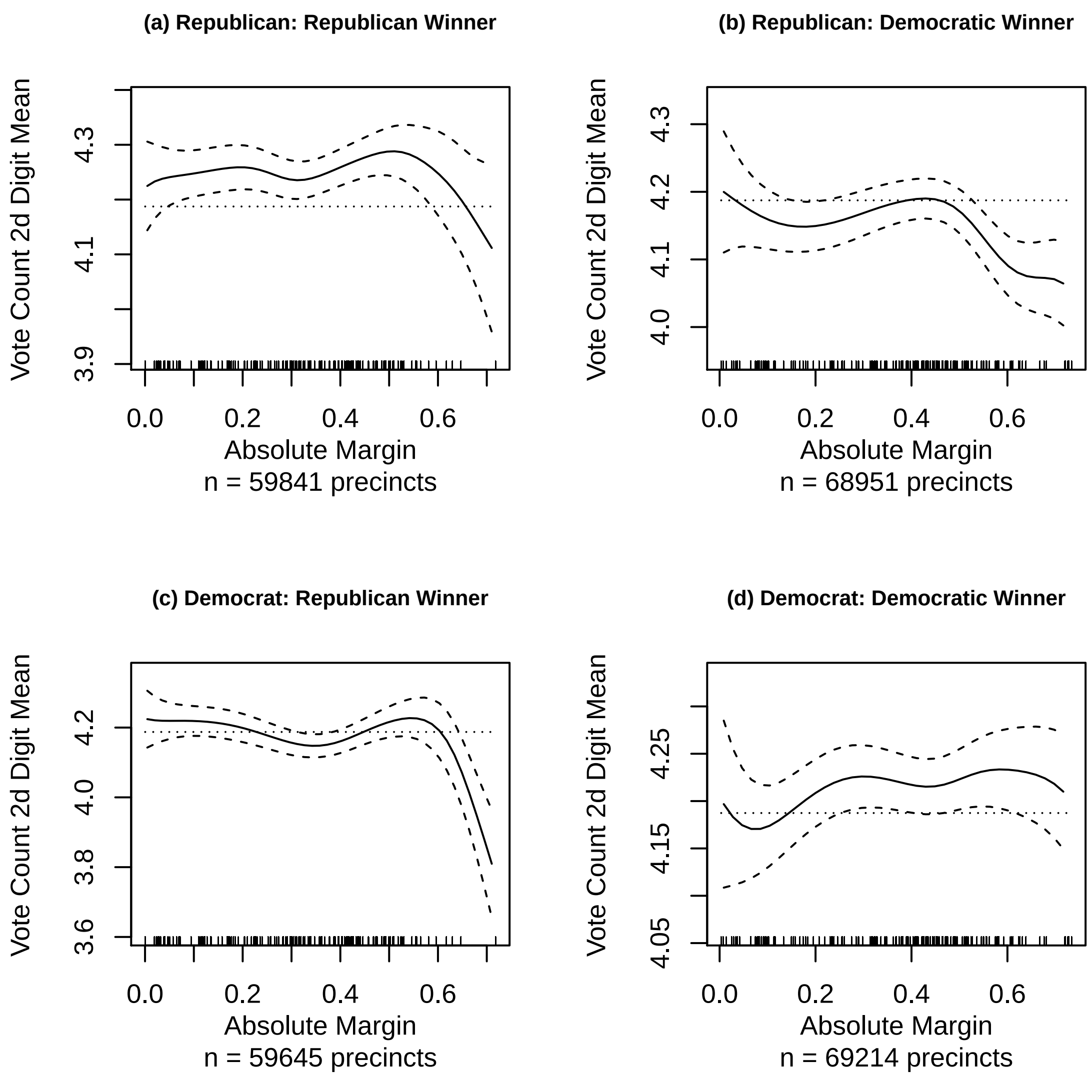
Notes: Statistics for *sección* vote counts. N is the number of *secciones* with a vote count > 9. $\alpha = (1 + [-ep\log(p)]^{-1})^{-1}$ where p is the p-value of X^2_{2BL}. $\hat{j}_{\mathrm{lo}}$ and $\hat{j}_{\mathrm{hi}}$ are the lower and upper bounds of the 95% confidence interval for $\hat{j}$.
Data source: Instituto Federal Electoral (2006, 2012*d*).

Figure 3: Vote Counts for United States Representative, 1984



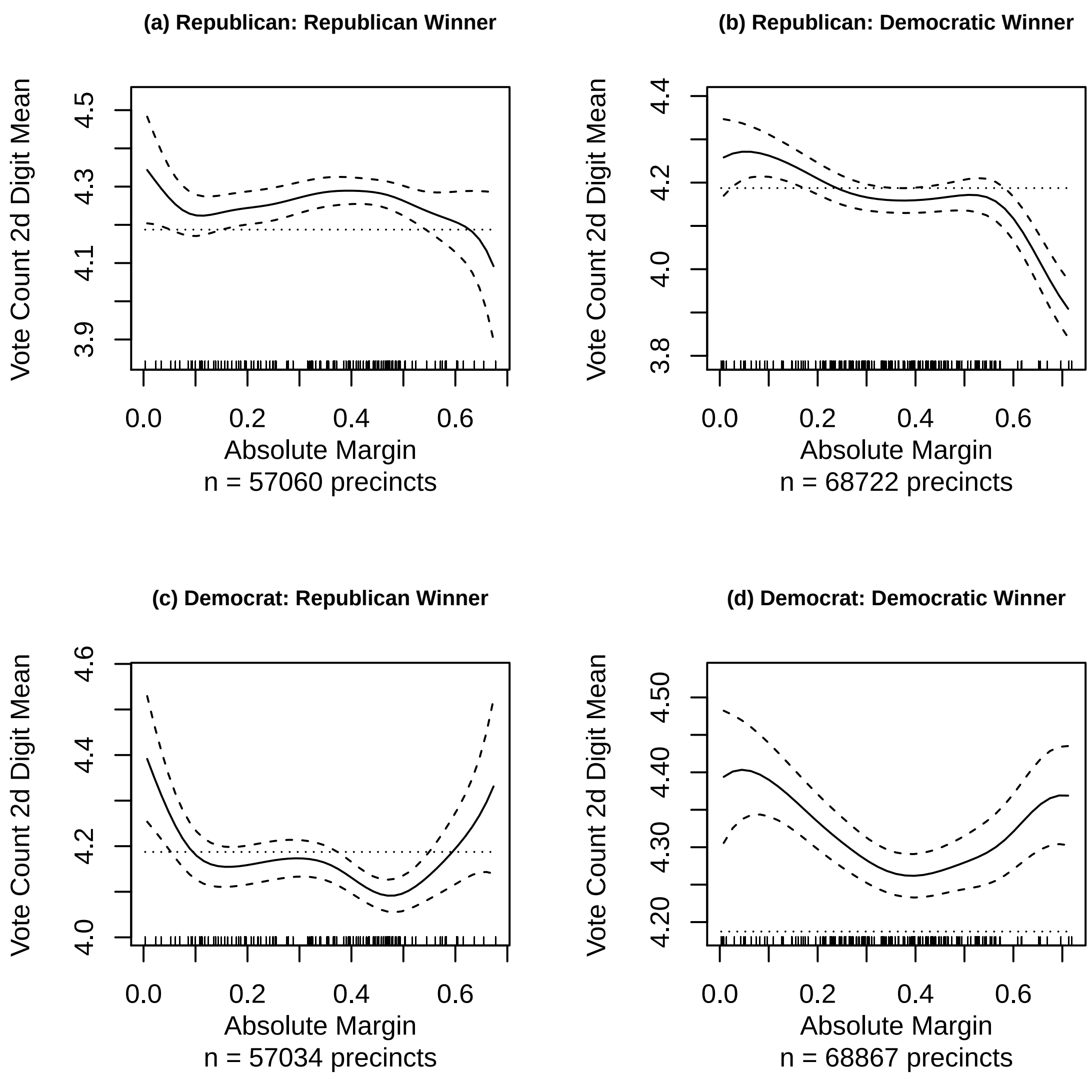
Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on ROAD precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes, using U.S. House Clerk official election returns data. Rug plots show the locations of district absolute margins.

Figure 4: Vote Counts for United States Representative, 1986



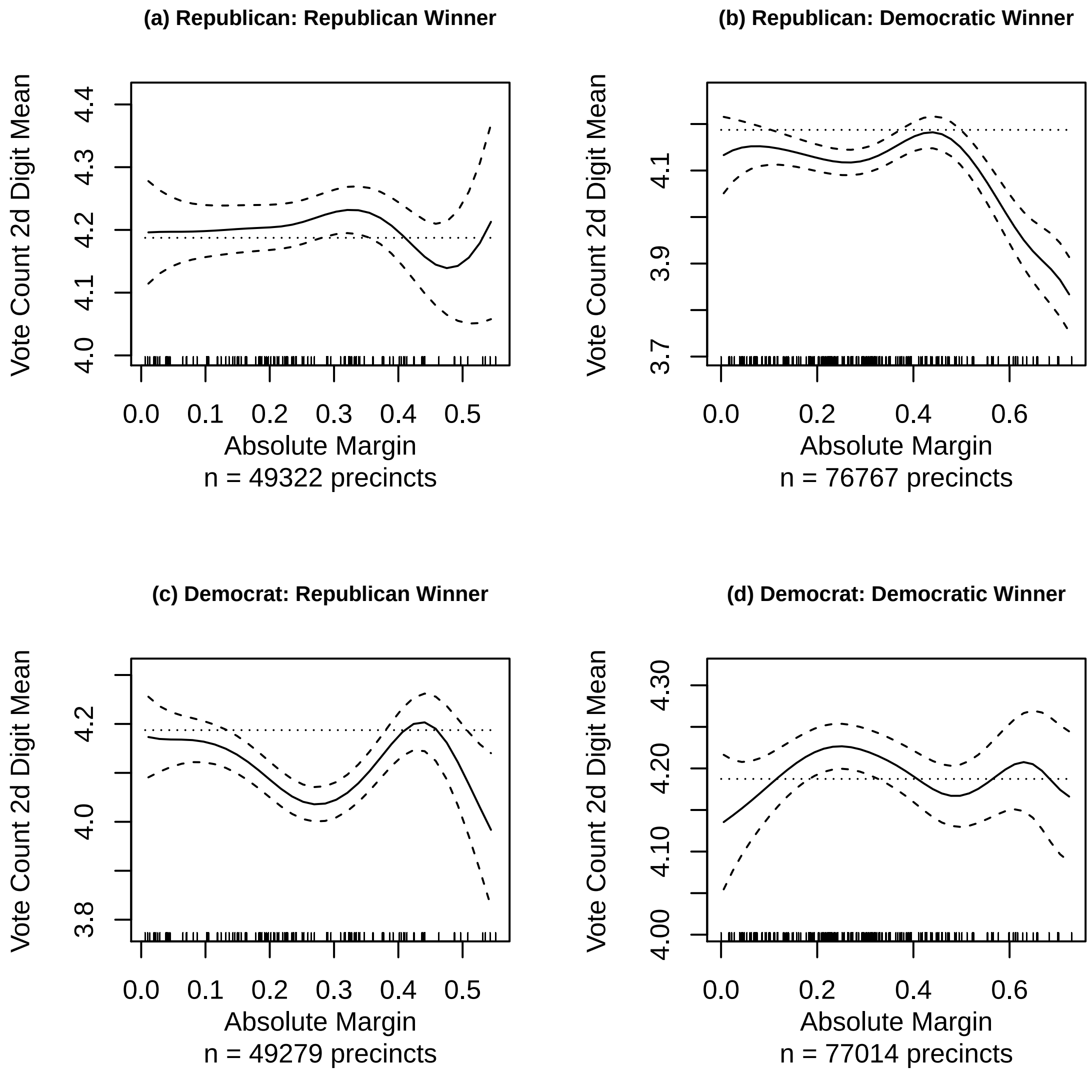
Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on ROAD precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes, using U.S. House Clerk official election returns data. Rug plots show the locations of district absolute margins.

Figure 5: Vote Counts for United States Representative, 1988



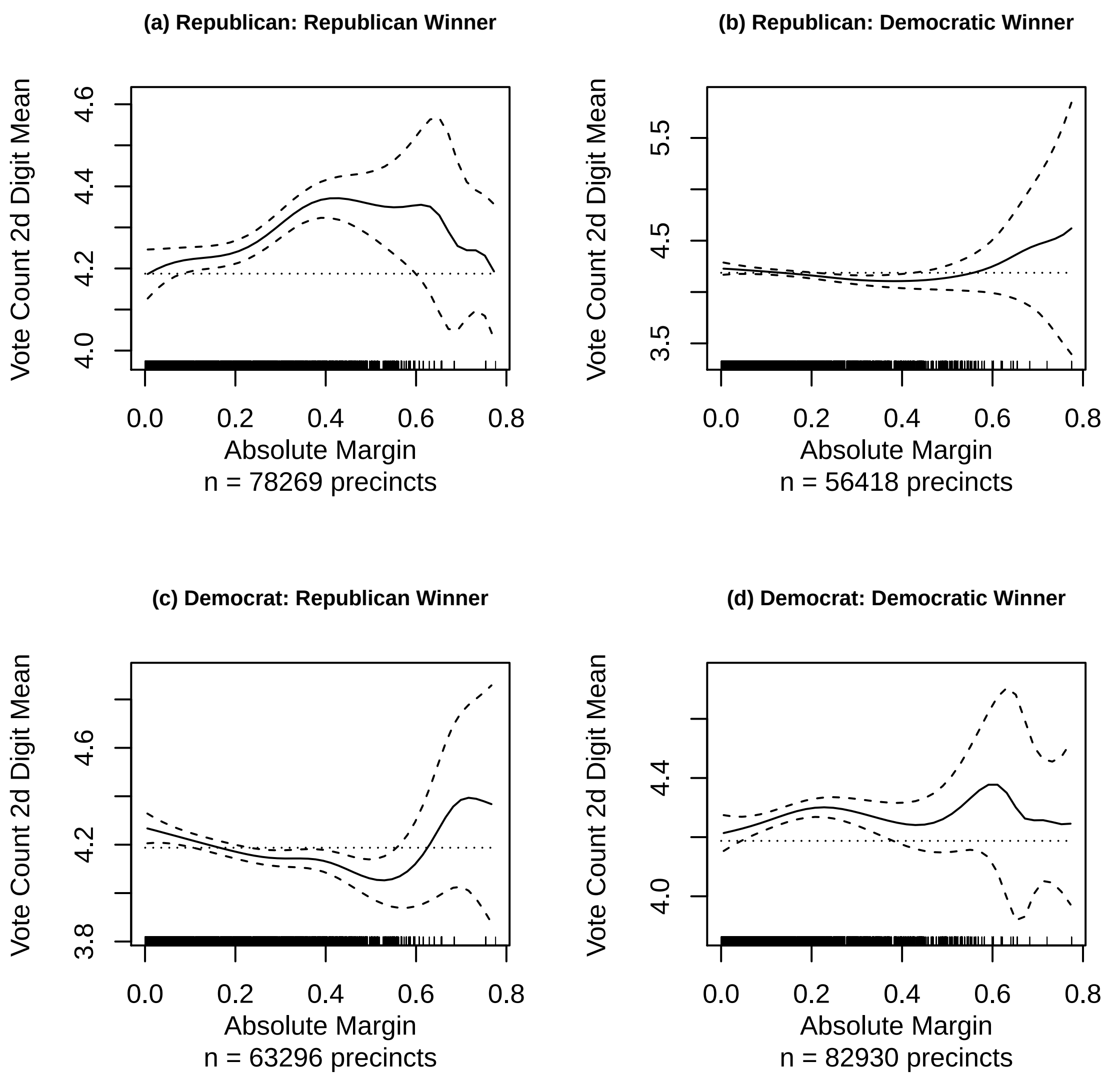
Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on ROAD precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes, using U.S. House Clerk official election returns data. Rug plots show the locations of district absolute margins.

Figure 6: Vote Counts for United States Representative, 1990



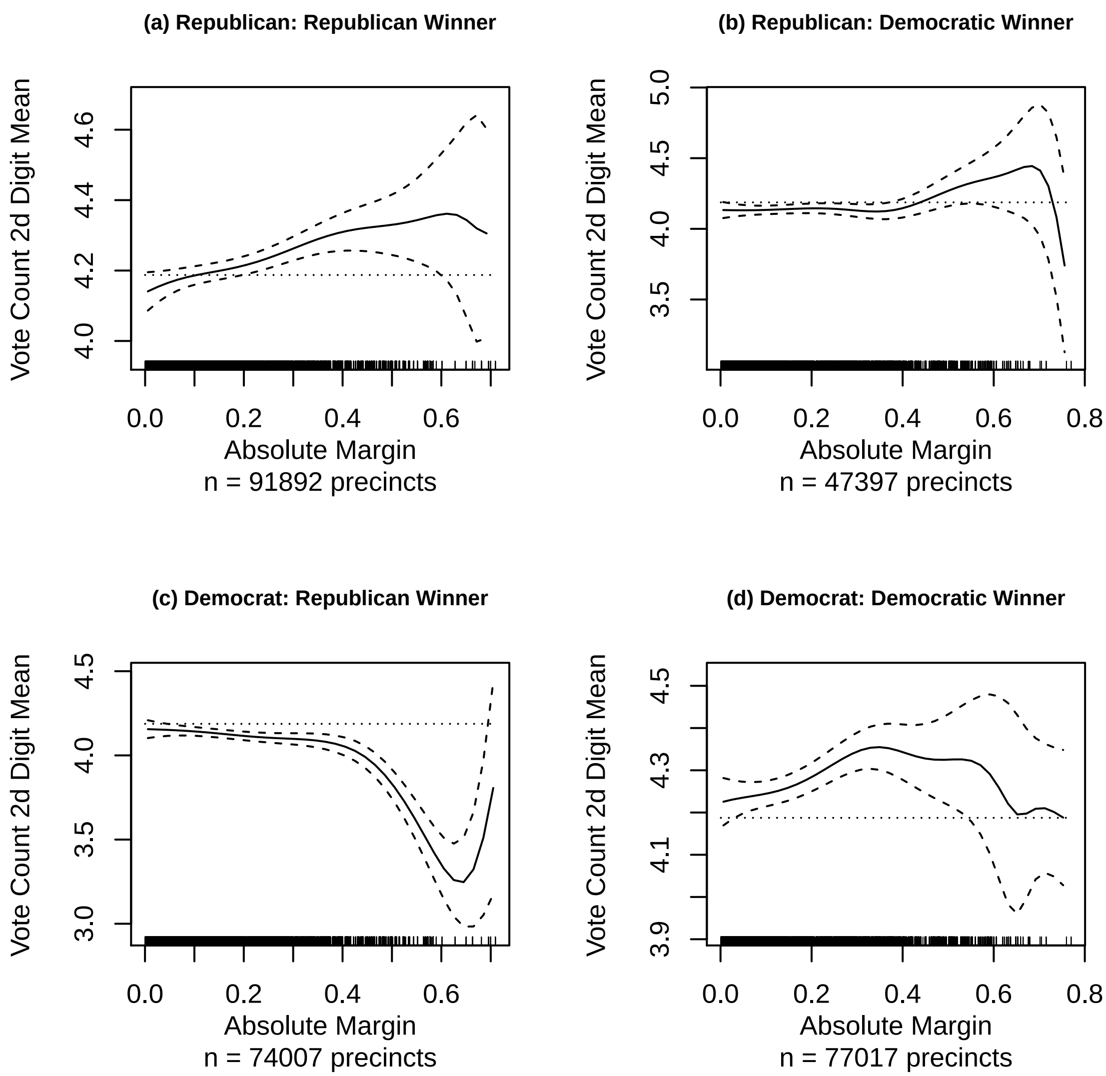
Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on ROAD precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes, using U.S. House Clerk official election returns data. Rug plots show the locations of district absolute margins.

Figure 7: Vote Counts for State House, 1984



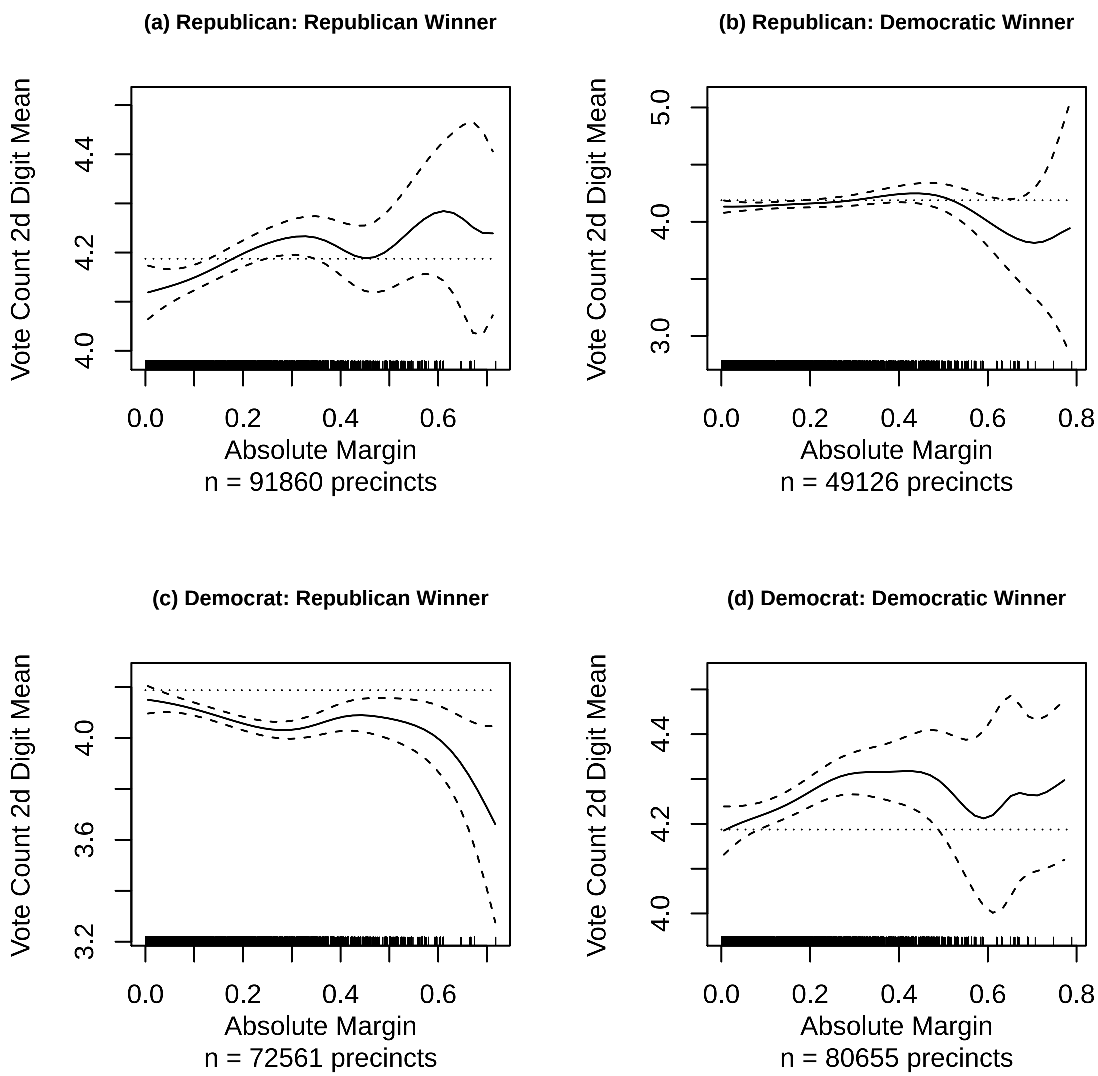
Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on ROAD precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes based on district totals computed from the precinct data. Rug plots show the locations of district absolute margins.

Figure 8: Vote Counts for State House, 1986



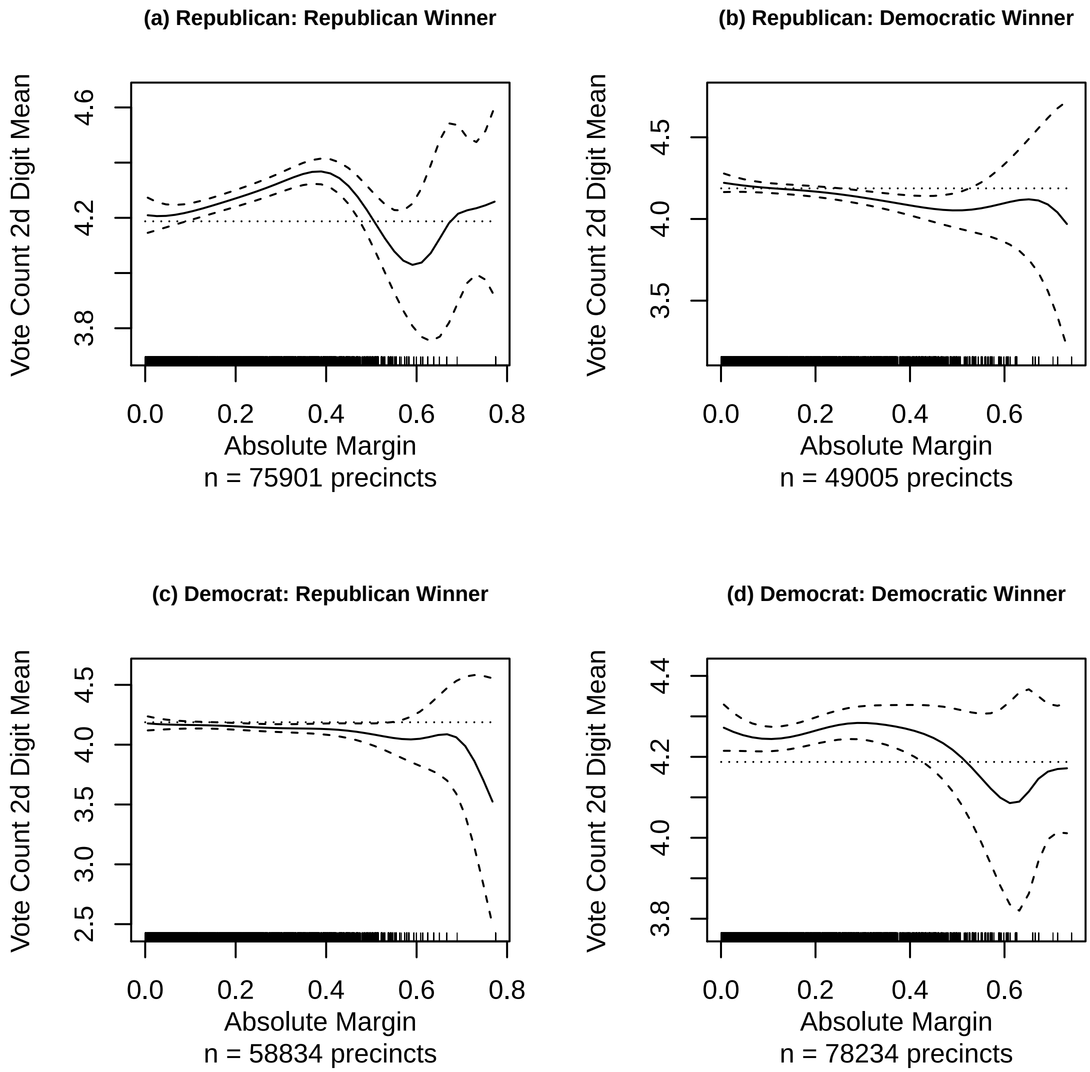
Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on ROAD precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes based on district totals computed from the precinct data. Rug plots show the locations of district absolute margins.

Figure 9: Vote Counts for State House, 1990



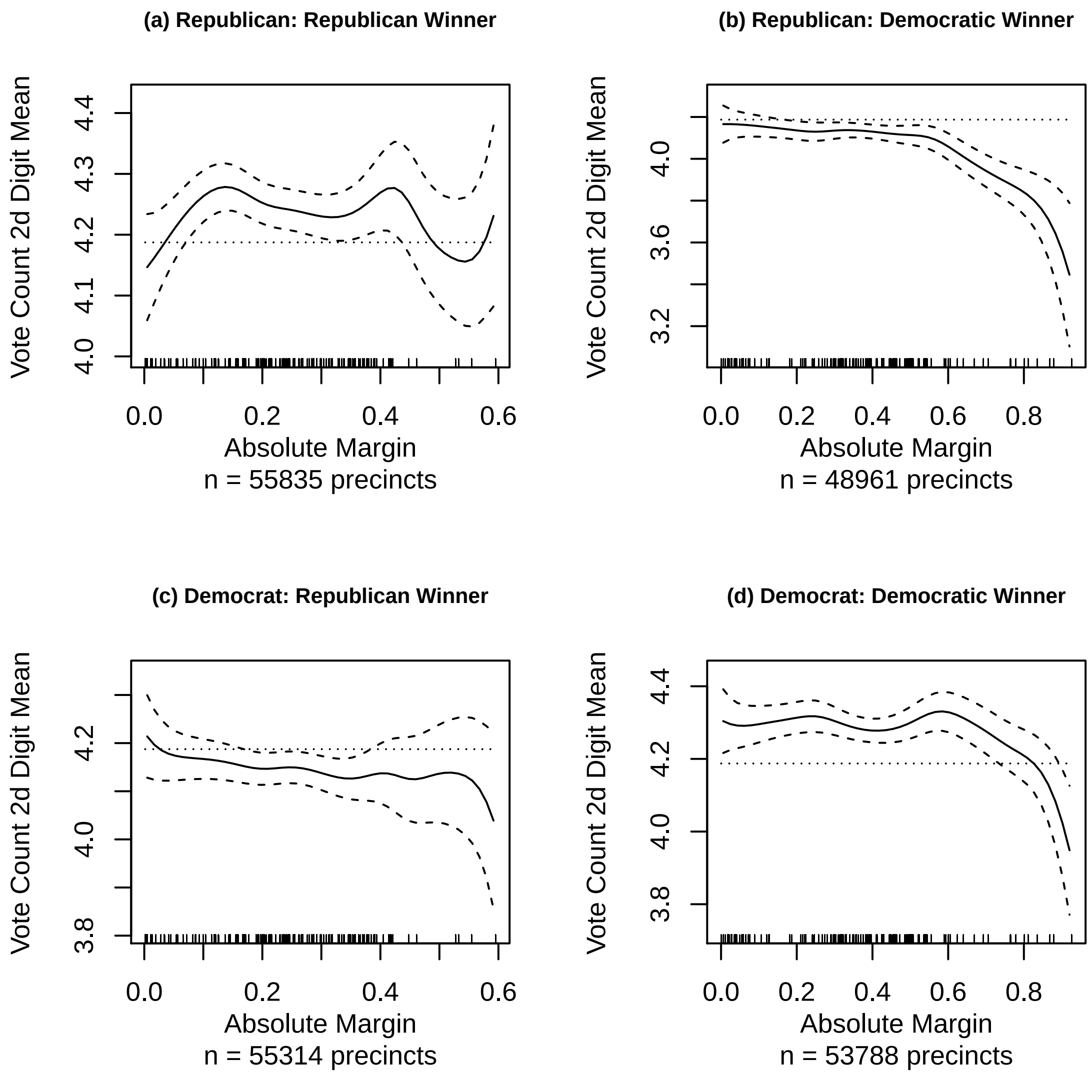
Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on ROAD precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes based on district totals computed from the precinct data. Rug plots show the locations of district absolute margins.

Figure 10: Vote Counts for State House, 1988



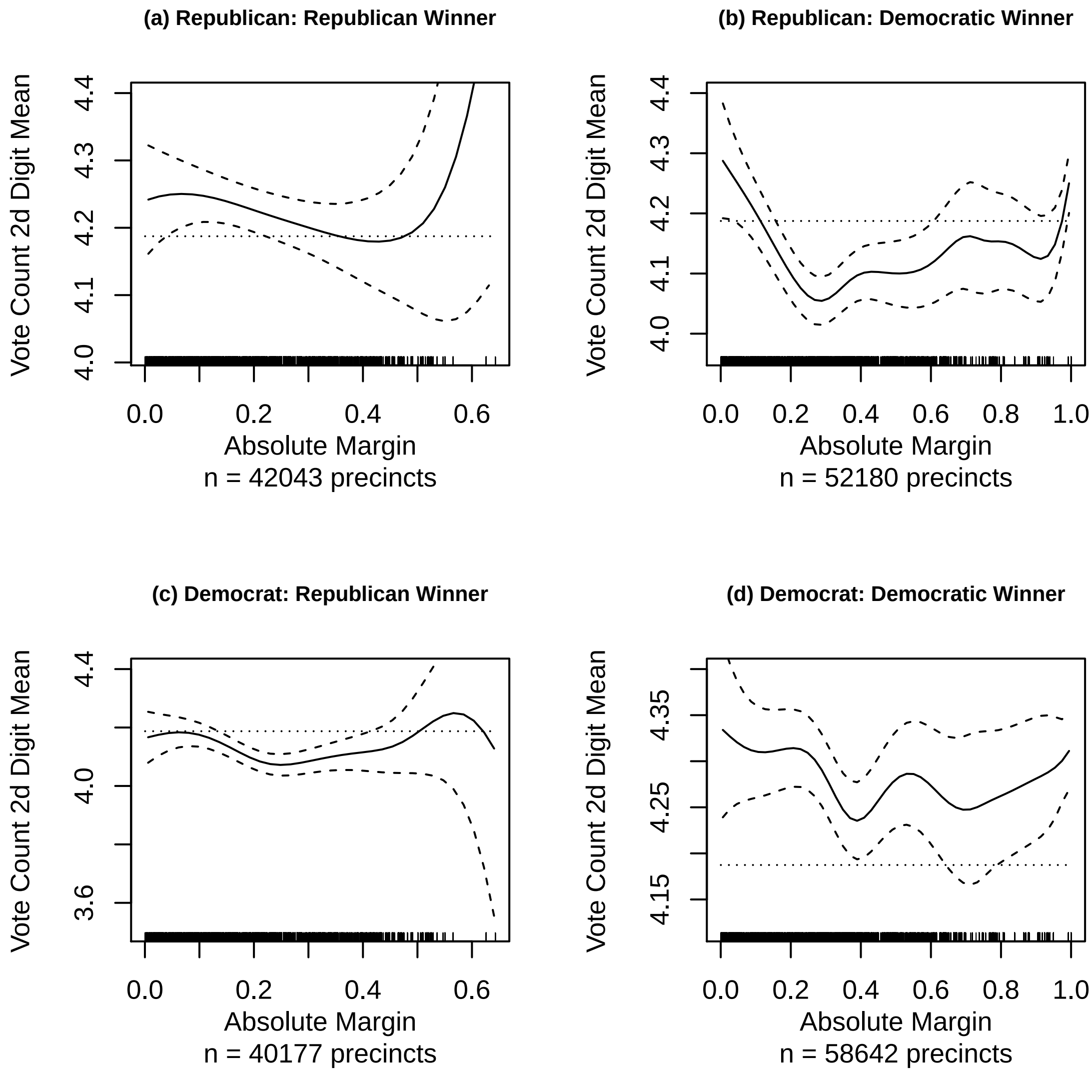
Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on ROAD precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes based on district totals computed from the precinct data. Rug plots show the locations of district absolute margins.

Figure 11: Vote Counts for United States Representative, 2006



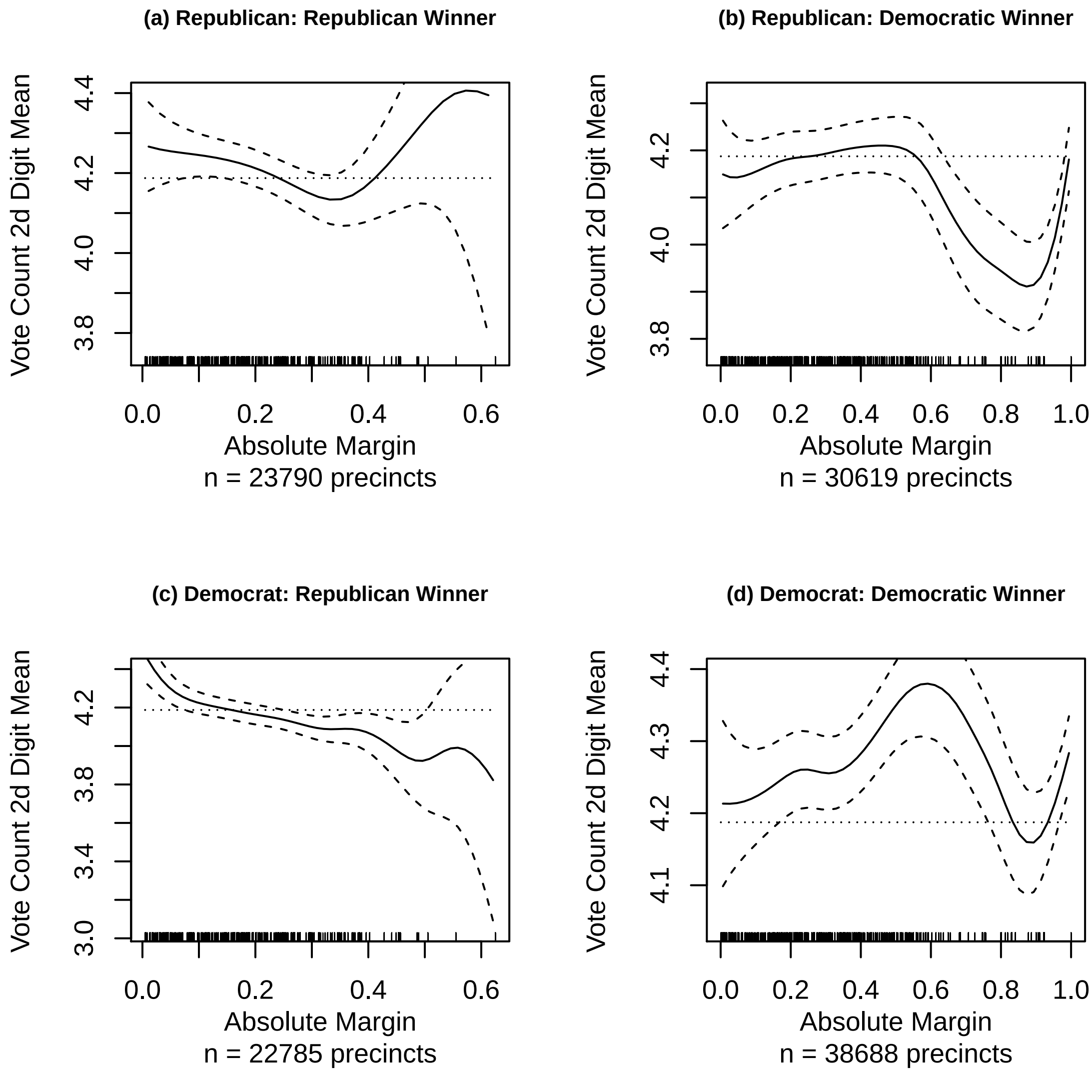
Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes, using U.S. House Clerk official election returns data. Rug plots show the locations of district absolute margins.

Figure 12: Vote Counts for State House, 2006



Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes based on district totals computed from the precinct data. Rug plots show the locations of district absolute margins.

Figure 13: Vote Counts for State Senate, 2006



Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes based on district totals computed from the precinct data. Rug plots show the locations of district absolute margins.

Table 9: United States: Political View Percentages in 2004 and Differences between 2004 and 2006

Political View	2004 percentage	difference: 2004 − 2006	difference 95% CI[a] lower	difference 95% CI[a] upper
Very conservative	8.0	−.145	−2.17	1.91
Conservative	36.2	4.96	1.09	8.43
Moderate	34.6	−7.46	−10.98	−3.61
Liberal	13.0	1.97	−.49	4.52
Very liberal	3.7	−1.24	−2.85	.46
DK/Refused	4.5	1.91	.47	3.37

Note: Percentage of likely voters in each ideological category in 2004 and difference between that percentage and the percentage in the category in 2006 during the weekend before the general election in each year. Data are from Pew Research Center (2004*a*, 2006*a*): $n = 2804$ adults in 2004 and $n = 2912$ in 2006. Survey respondents are weighted using sampling and likely voter weights, with likely voter weights chosen to match the turnout actually observed in the elections.
[a] 95% confidence interval estimated using the nonparametric studentized bootstrap stratified by year.

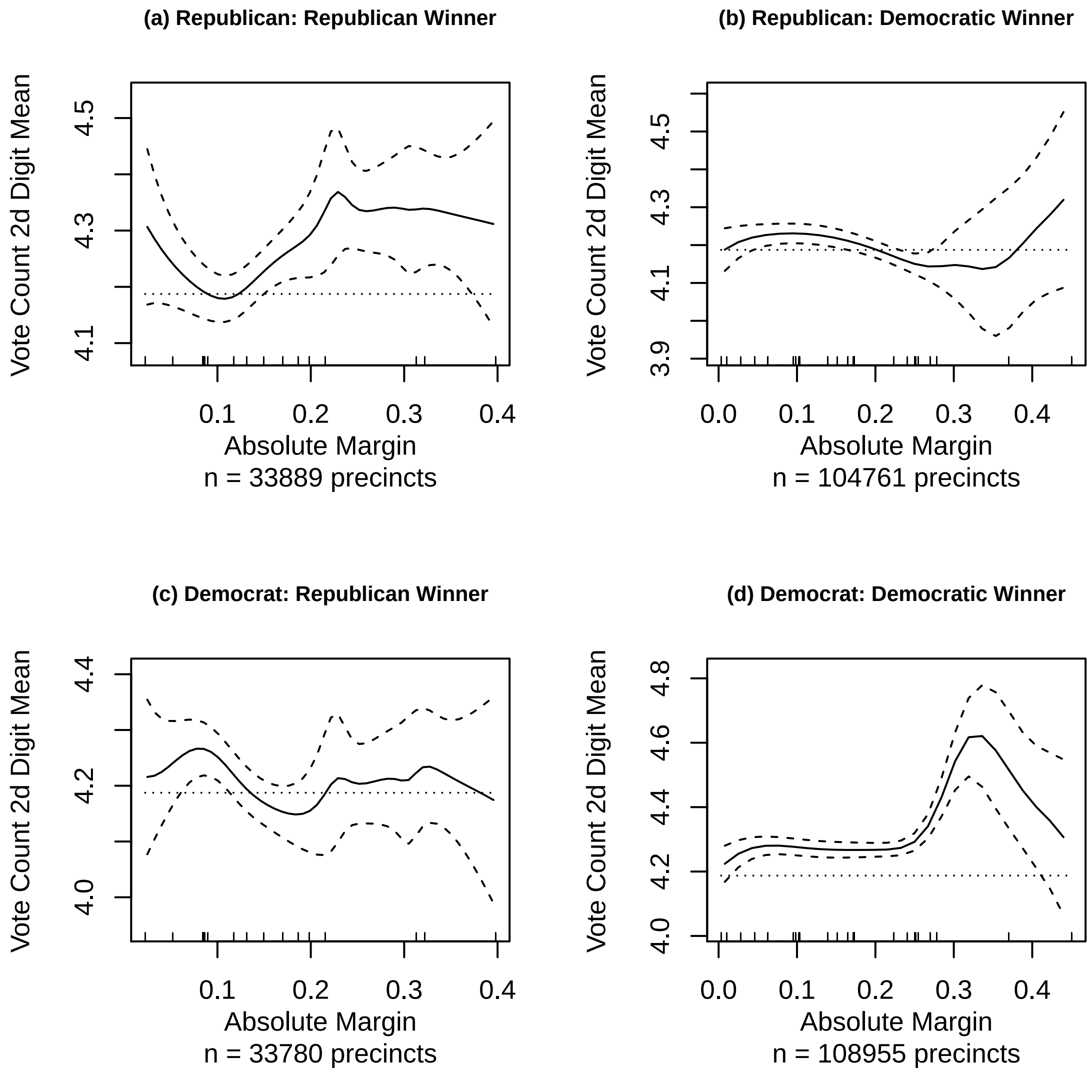
Table 10: United States: Voting Intentions in 2004 Presidential and 2006 Midterm Election-weekend Surveys, Logistic Regression

Variable	Coef.	95% CI[a] lower	95% CI[a] upper
(Intercept)	−1.20	−1.41	−.997
View: Very conservative	−.567	−1.153	−.0191
View: Moderate	1.65	1.37	1.92
View: Liberal	3.48	2.93	4.10
View: Very liberal	3.87	3.10	4.98
View: DK/Refused	1.72	1.08	2.33
Midterm	−.0231	−.372	.328
Midterm × View: Very conservative	−.0713	−1.05	.858
Midterm × View: Moderate	.235	−.221	.693
Midterm × View: Liberal	.0528	−.883	1.04
Midterm × View: Very liberal	−.167	−1.41	1.09
Midterm × View: DK/Refused	.285	−.921	1.62

Note: Logistic regression model for the intention (during the weekend before the election) of likely voters to vote Democratic (as opposed to Republican) in the 2004 presidential and 2006 midterm elections in the United States. Data are from Pew Research Center (2004*a*, 2006*a*): $n = 2804$ adults in 2004 and $n = 2912$ in 2006. Survey respondents are weighted using sampling and likely voter weights, with likely voter weights chosen to match the turnout actually observed in the elections. "Conservative" is the category associated with the intercept; other effects are relative to that category.

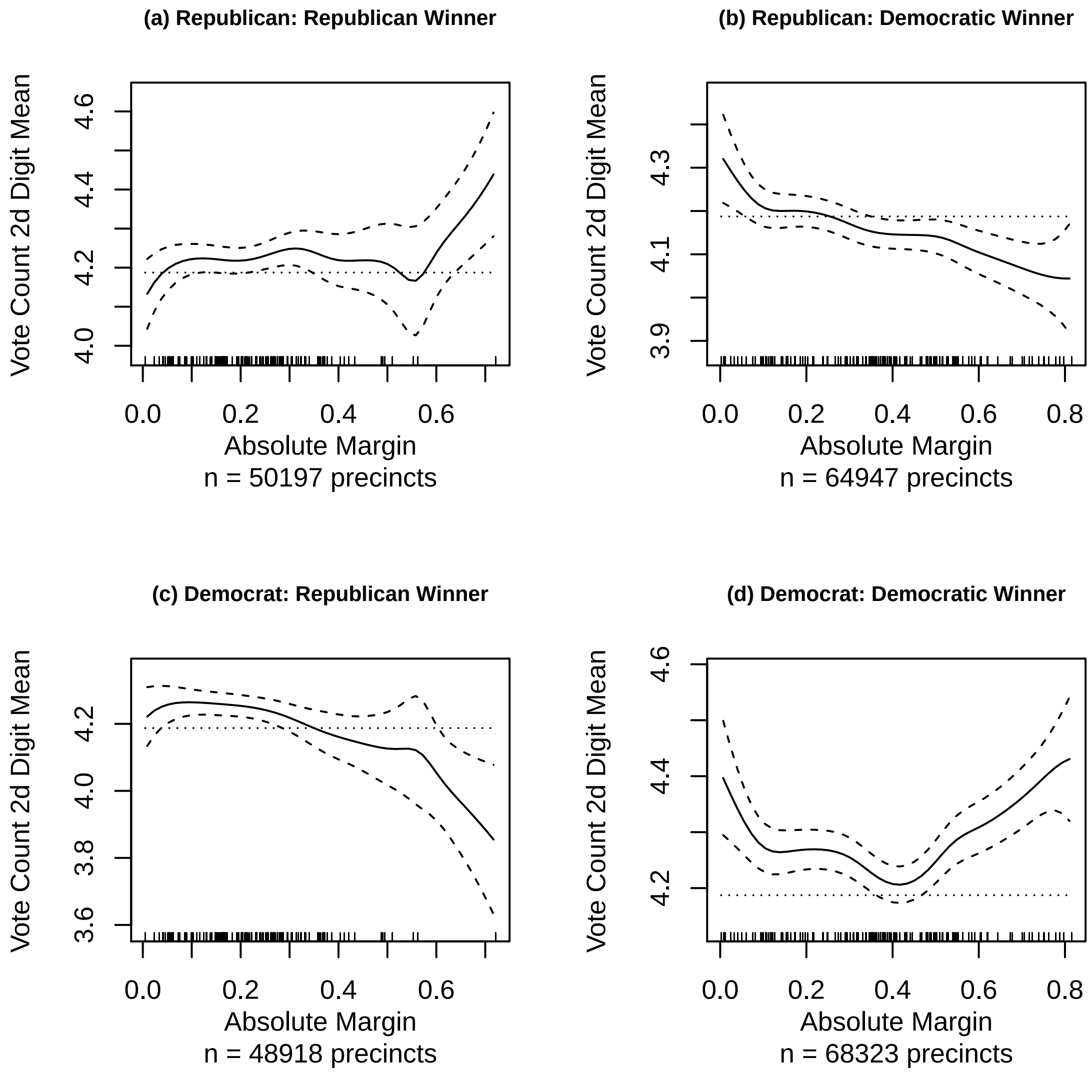
[a] 95% confidence interval estimated using the nonparametric studentized bootstrap stratified by year.

Figure 14: Vote Counts for President, 2008



Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the total of votes cast for president, using U.S. House Clerk official election returns data. Rug plots show the locations of state absolute margins.

Figure 15: Vote Counts for United States Representative, 2008



Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes, using U.S. House Clerk official election returns data. Rug plots show the locations of district absolute margins.

Table 11: United States: Political View Percentages in 2000 and 2008 and Differences between 2000 and 2002 and between 2008 and 2010

Political View	2000 percentage	difference: 2000 − 2002	difference 95% CI[a] lower	upper
Very conservative	6.3	−.876	−3.06	1.27
Conservative	36.2	.0264	−4.31	4.01
Moderate	37.2	.636	−3.14	4.56
Liberal	12.6	−.329	−2.93	2.43
Very liberal	2.9	.362	−1.04	1.66
DK/Refused	4.8	.180	−1.50	1.86

Political View	2008 percentage	difference: 2008 − 2010	difference 95% CI[a] lower	upper
Very conservative	9.6	−3.00	−5.32	−.79
Conservative	32.9	−2.32	−5.84	1.44
Moderate	32.8	2.13	−1.36	5.63
Liberal	14.3	1.53	−1.07	4.03
Very liberal	4.7	.0626	−1.63	1.82
DK/Refused	5.7	1.59	−.04	3.20

Note: Percentage of likely voters in each ideological category in 2000 and difference between that percentage and the percentage in the category in 2002 during the weekend before the general election in each year, along with corresponding quantities in 2008 and 2010. Data are from Pew Research Center (2000, 2002, 2008, 2010): $n = 2898$ adults in 2000, $n = 2113$ in 2002, $n = 3402$ in 2008 and $n = 3005$ in 2010. Survey respondents are weighted using sampling and likely voter weights, with likely voter weights chosen to match the turnout actually observed in each election.
[a] 95% confidence interval estimated using the nonparametric studentized bootstrap stratified by year.

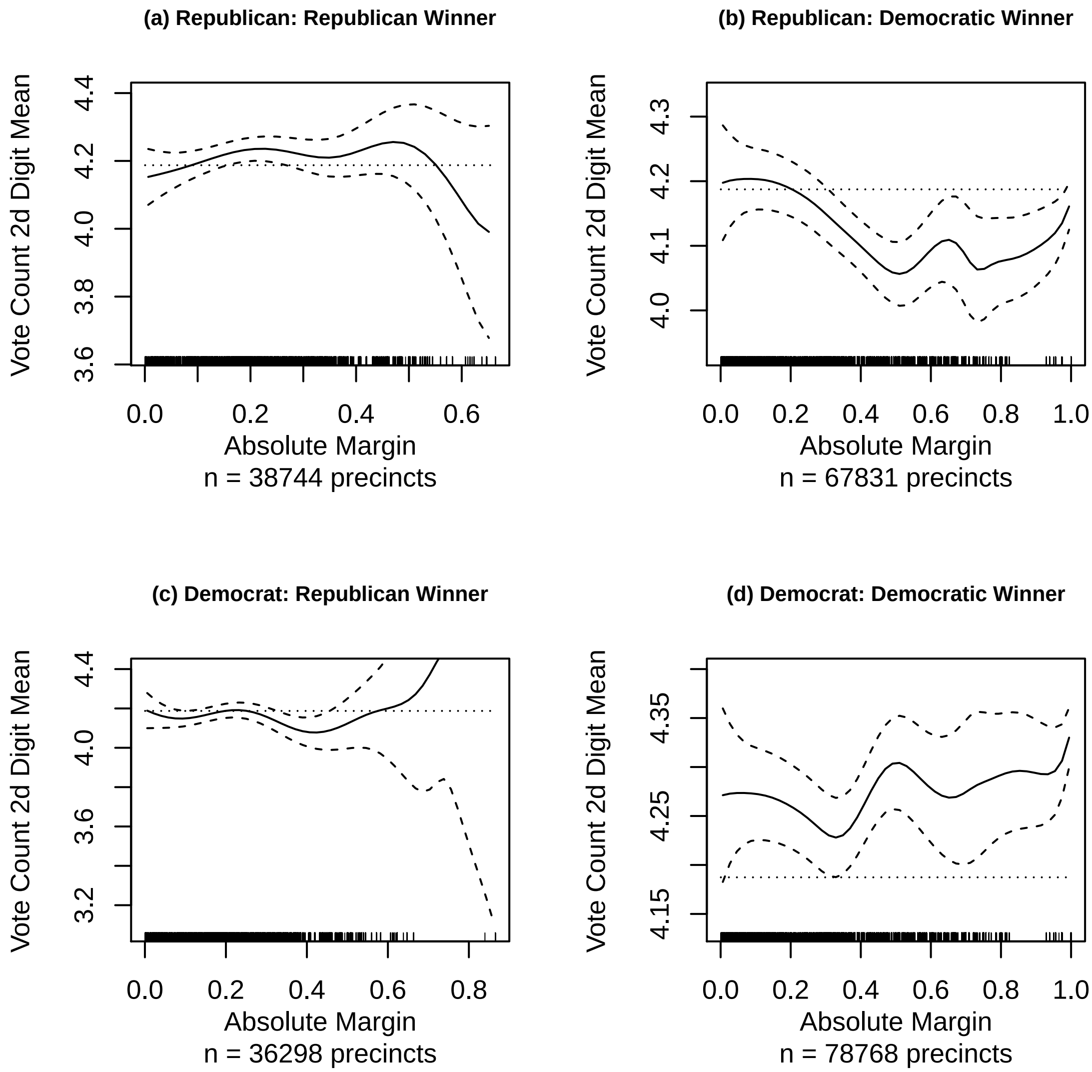
Table 12: United States: Voting Intentions in 2000 and 2008 Presidential and 2002 and 2010 Midterm Election-weekend Surveys, Logistic Regression

	2000 and 2002			2008 and 2010		
		95% CI[a]			95% CI[a]	
Variable	Coef.	lower	upper	Coef.	lower	upper
(Intercept)	−.985	−1.20	−.767	−.927	−1.13	−.732
View: Very conservative	−1.20	−2.20	−.520	−.582	−1.12	−.0800
View: Moderate	1.42	1.12	1.71	1.41	1.14	1.68
View: Liberal	2.86	2.39	3.38	4.12	3.54	4.82
View: Very liberal	3.87	3.17	5.43	3.83	2.99	5.21
View: DK/Refused	1.77	1.15	2.40	1.80	1.19	2.43
Midterm	.158	−.180	.505	−.398	−.727	−.0582
Midterm × View: Very conservative	.551	−.604	1.60	−1.03	−1.99	−.168
Midterm × View: Moderate	−.106	−.585	.340	.269	−.182	.702
Midterm × View: Liberal	.157	−.712	1.06	−.732	−1.69	.146
Midterm × View: Very liberal	8.39	7.46	20.5	1.23	−.007	3.22
Midterm × View: DK/Refused	−.994	−2.02	.0505	−.488	−1.55	.620

Note: Logistic regression models for the intention (during the weekend before the election) of likely voters to vote Democratic (as opposed to Republican) in the 2000 presidential and 2002 midterm elections and in the 2008 presidential and 2010 midterm elections in the United States. Data are from Pew Research Center (2000, 2002, 2008, 2010): $n = 2898$ adults in 2000, $n = 2113$ in 2002, $n = 3402$ in 2008 and $n = 3005$ in 2010. Survey respondents are weighted using sampling and likely voter weights, with likely voter weights chosen to match the turnout actually observed in each election. "Conservative" is the category associated with the intercept; other effects are relative to that category.

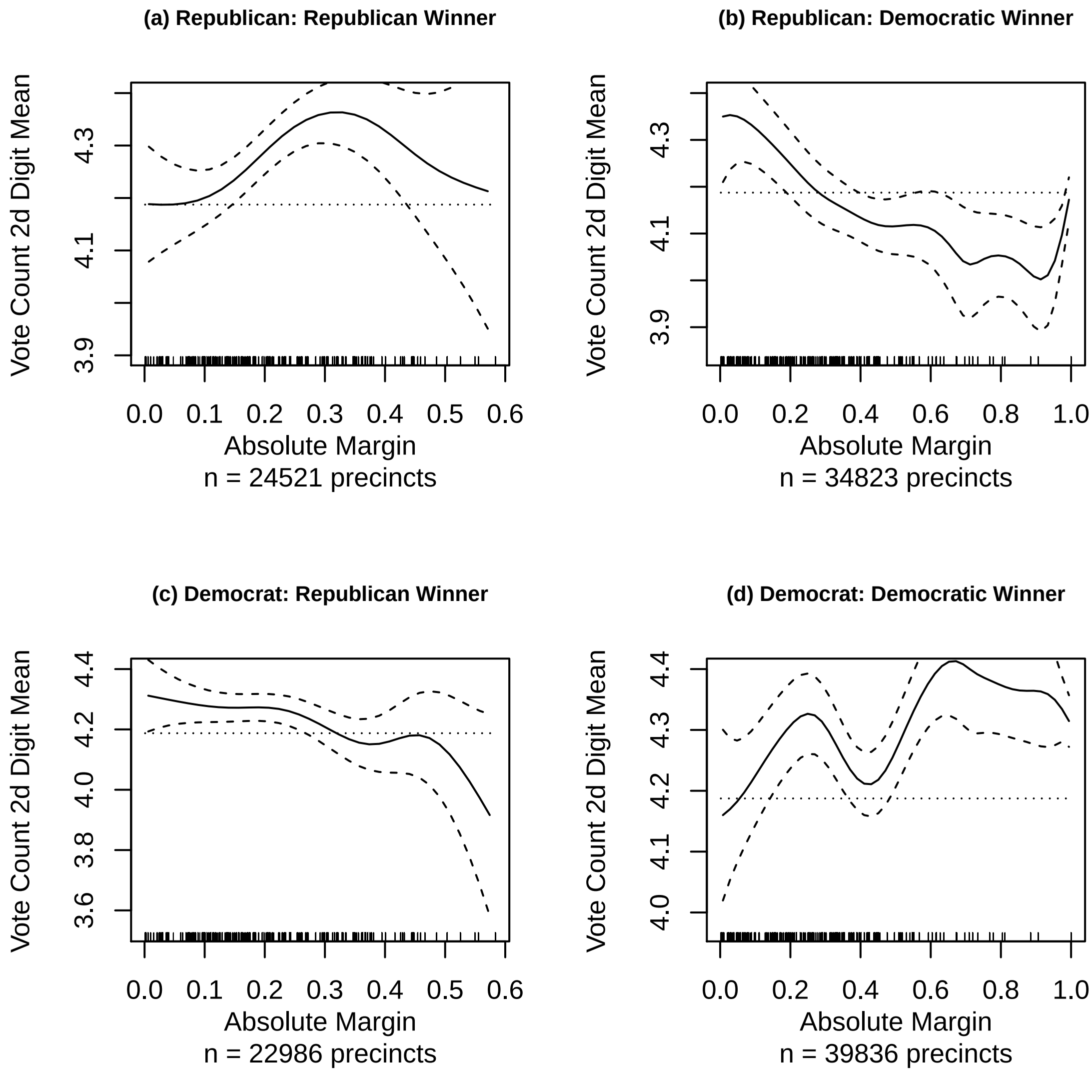
[a] 95% confidence interval estimated using the nonparametric studentized bootstrap stratified by year.

Figure 16: Vote Counts for State House, 2008



Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes based on district totals computed from the precinct data. Rug plots show the locations of district absolute margins.

Figure 17: Vote Counts for State Senate, 2008



Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes based on district totals computed from the precinct data. Rug plots show the locations of district absolute margins.

Table 13: United States: Political View Percentages in 2008 and Differences from 2006 and 2004

	2008	2008 − 2006 difference 95% CI[a]		2008 − 2004 difference 95% CI[a]		2008 − 2004 difference 90% CI[b]	
Political View	percentage	lower	upper	lower	upper	lower	upper
Very conservative	9.6	−.64	3.59	−.54	3.50	.01	3.22
Conservative	32.9	−1.91	4.88	−6.62	.01	−5.86	−.40
Moderate	32.8	−12.74	−5.80	−4.98	1.48	−4.50	.82
Liberal	14.3	1.03	5.82	−.92	3.72	−.73	3.29
Very liberal	4.7	−2.15	1.50	−.53	2.30	−.20	2.11
DK/Refused	5.7	1.59	4.51	−.34	2.69	−.22	2.48

Note: Percentage of likely voters in each ideological category in 2008 and difference between that percentage and the percentage in the category in 2006 and in 2004 during the weekend before the general election in each year. Data are from Pew Research Center (2004*a*, 2006*a*, 2008): $n = 2804$ adults in 2004, $n = 2912$ in 2006 and $n = 3402$ in 2008. Survey respondents are weighted using sampling and likely voter weights, with likely voter weights chosen to match the turnout actually observed in the elections.
[a] 95% and [b] 90% confidence interval estimated using the nonparametric studentized bootstrap stratified by year.

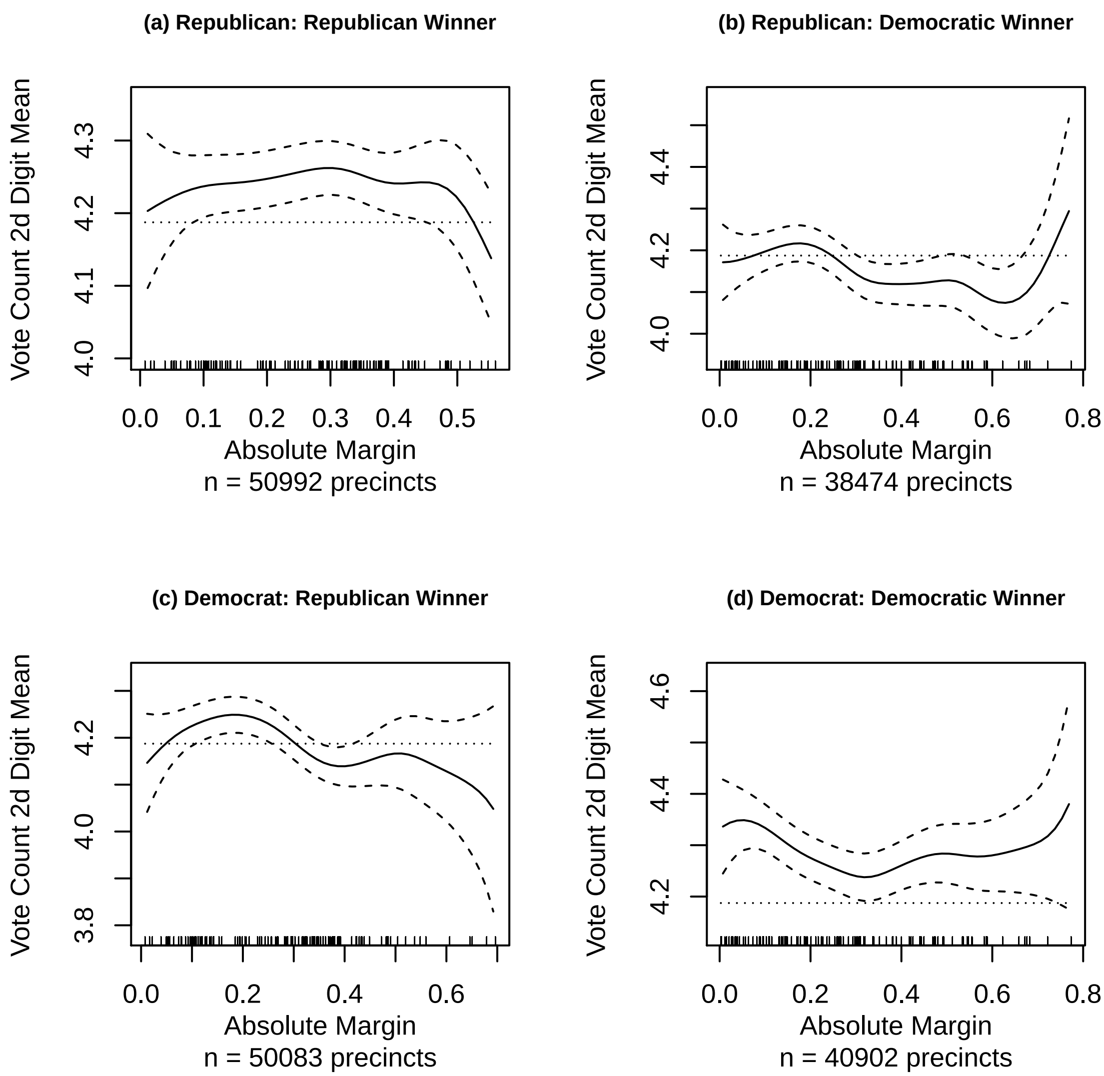
Table 14: United States: Voting Intentions in 2008 Presidential and 2006 Midterm Election-weekend Surveys, Logistic Regression

Variable	Coef.	95% CI[a] lower	95% CI[a] upper
(Intercept)	−.937	−1.15	−.749
View: Very conservative	−.570	−1.11	−.075
View: Moderate	1.41	1.14	1.69
View: Liberal	4.12	3.54	4.72
View: Very liberal	3.83	3.04	5.21
View: DK/Refused	1.80	1.23	2.43
Previous Midterm	−.288	−.615	.0523
Previous Midterm × View: Very conservative	−.0690	−1.03	.757
Previous Midterm × View: Moderate	.476	.0255	.914
Previous Midterm × View: Liberal	−.585	−1.51	.409
Previous Midterm × View: Very liberal	−.128	−1.40	1.25
Previous Midterm × View: DK/Refused	.200	−.958	1.59

Note: Logistic regression model for the intention (during the weekend before the election) of likely voters to vote Democratic (as opposed to Republican) in the 2008 presidential and 2006 midterm elections in the United States. Data are from Pew Research Center (2006*a*, 2008): $n = 2912$ adults in 2006 and $n = 3402$ in 2008. Survey respondents are weighted using sampling and likely voter weights, with likely voter weights chosen to match the turnout actually observed in the elections. "Conservative" is the category associated with the intercept; other effects are relative to that category.

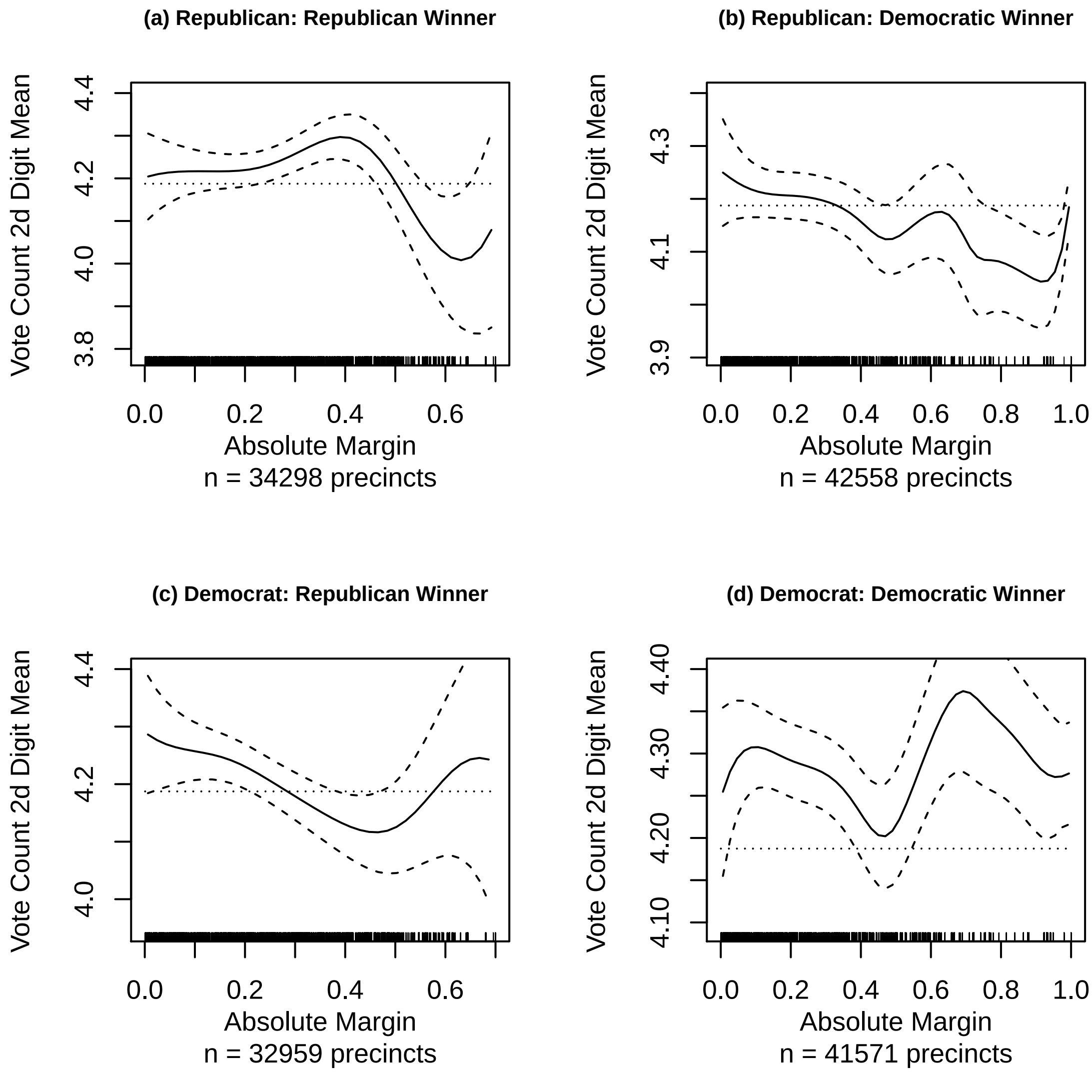
[a] 95% confidence interval estimated using the nonparametric studentized bootstrap stratified by year.

Figure 18: Vote Counts for United States Representative, 2010



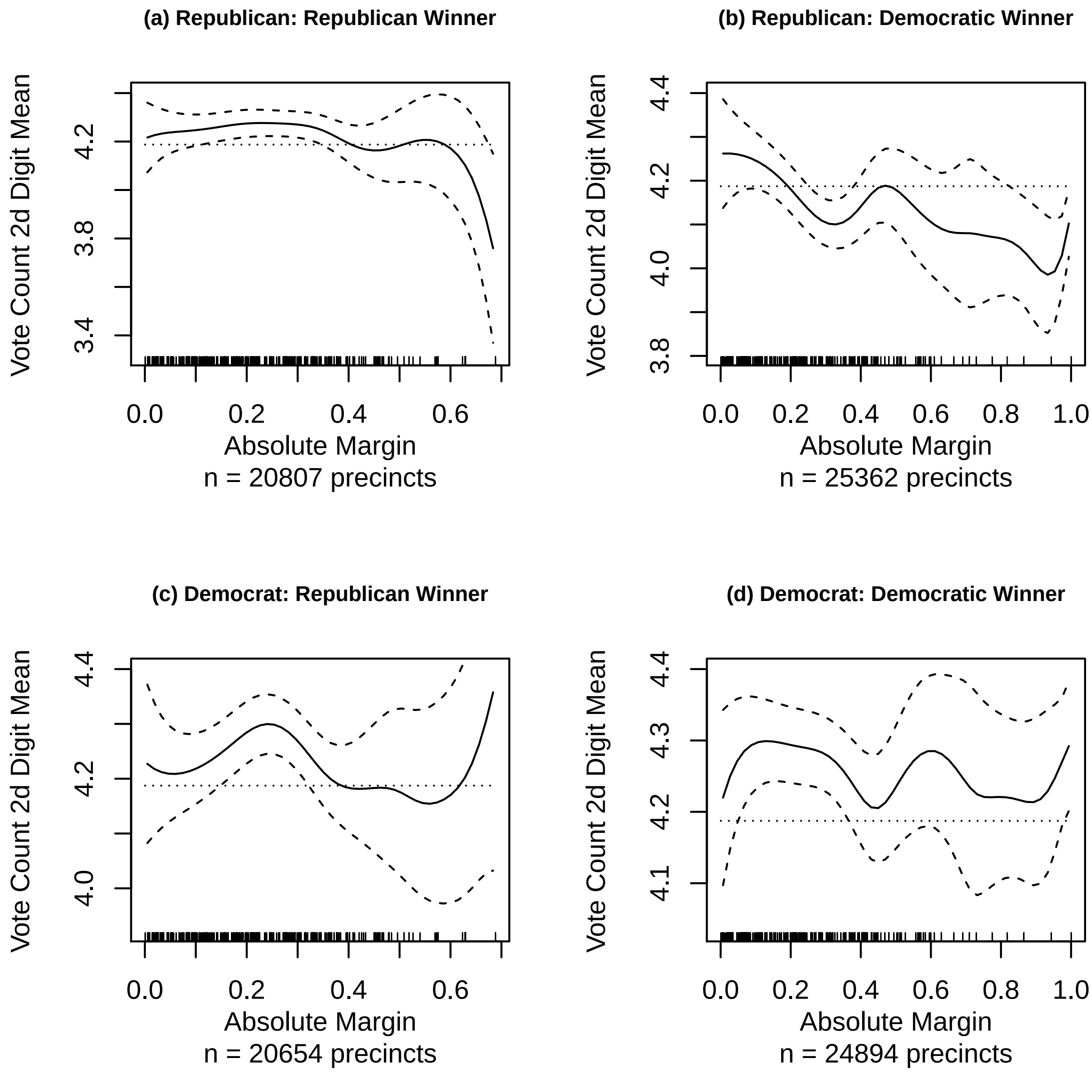
Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes, using U.S. House Clerk official election returns data. Rug plots show the locations of district absolute margins.

Figure 19: Vote Counts for State House, 2010



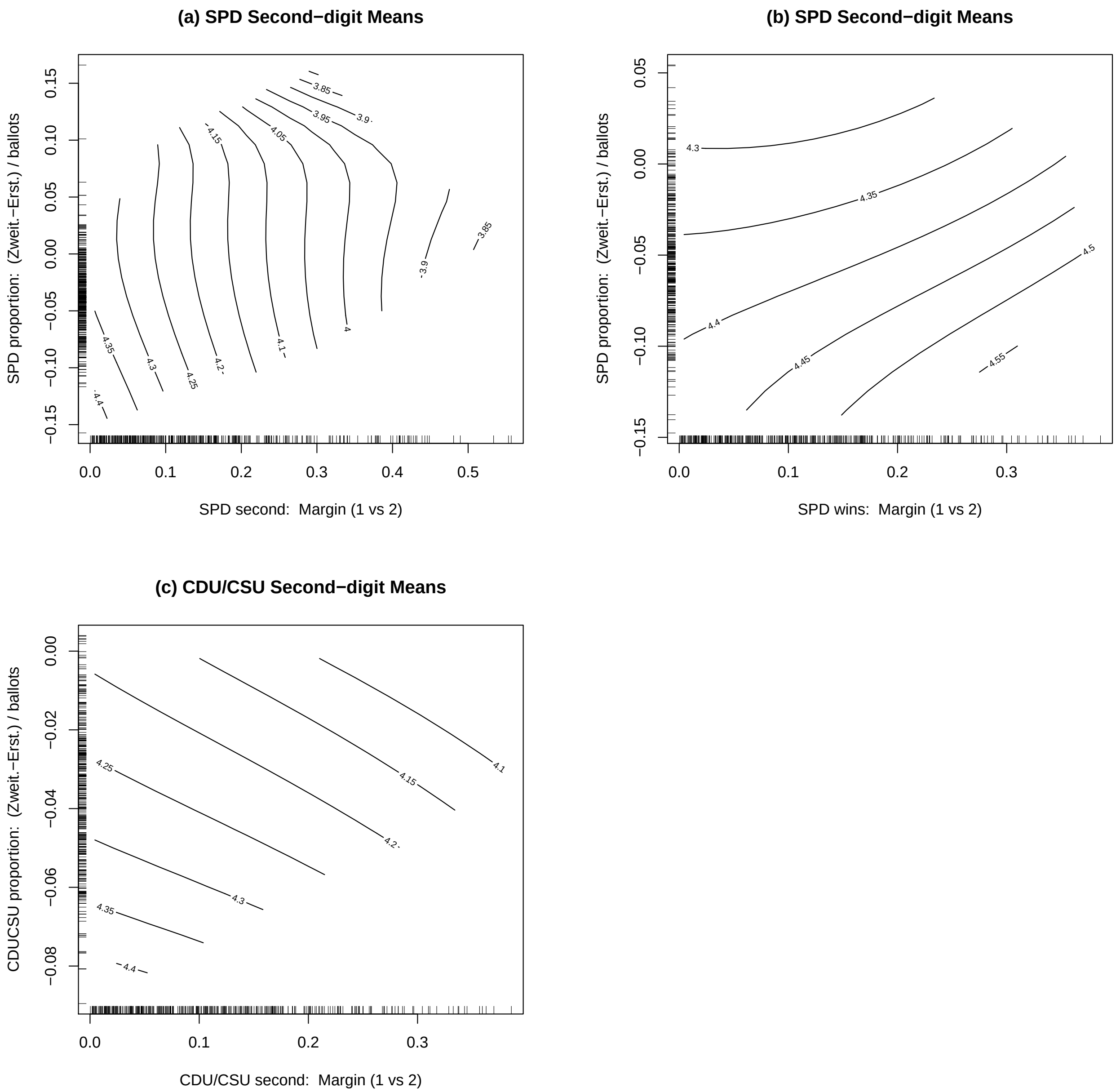
Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes based on district totals computed from the precinct data. Rug plots show the locations of district absolute margins.

Figure 20: Vote Counts for State Senate, 2010



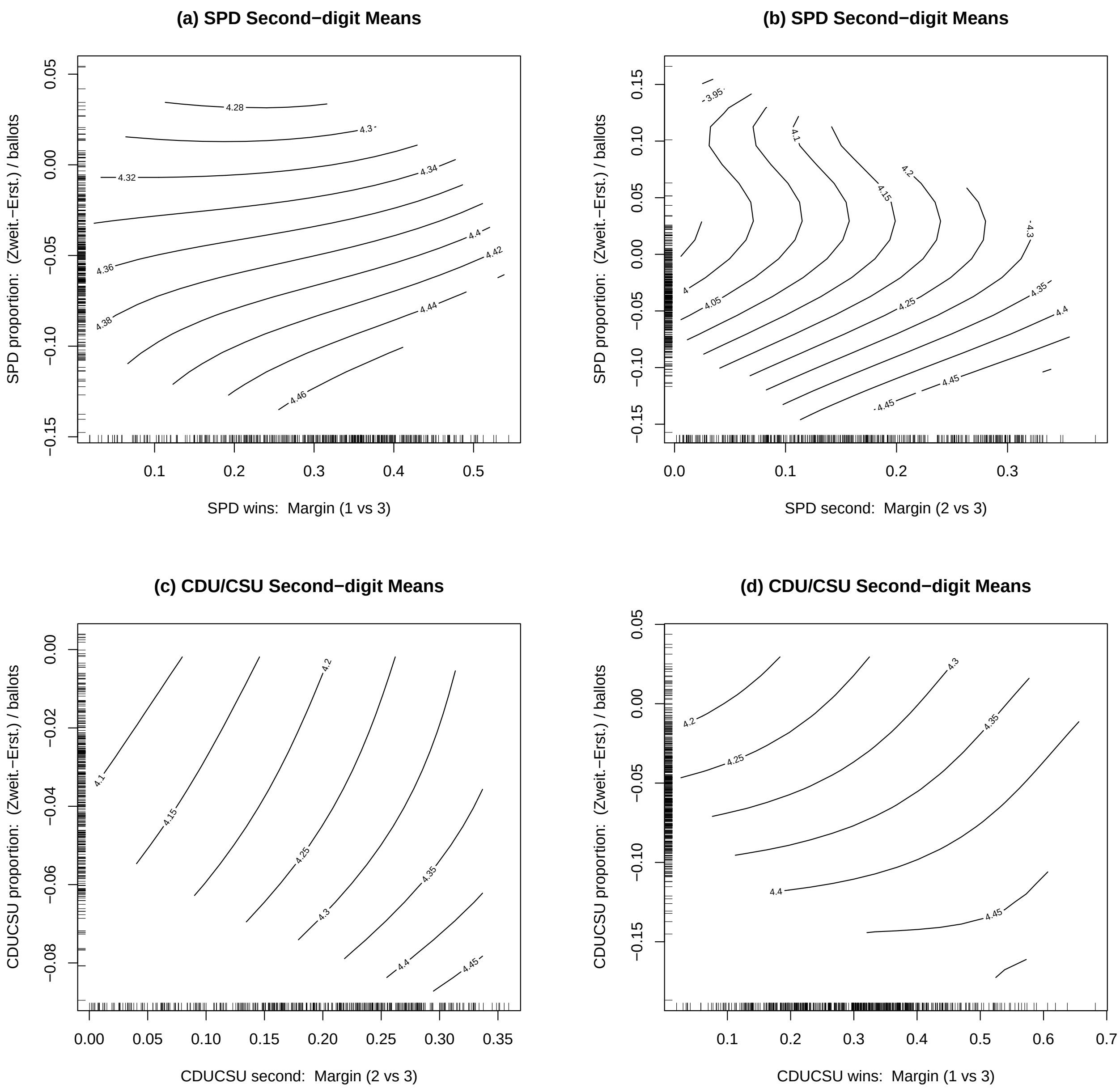
Note: Nonparametric regression curve (solid) with $\pm 1.96 \times$ s.e. curves (dashed). The dotted line shows the location of the second-digit mean expected under Benford's Law. "Vote Count 2d Digit Mean" is based on precinct data. "Absolute Margin" is based on the ratio of votes for the Democrat minus votes for the Republican divided by the sum of those two categories of votes based on district totals computed from the precinct data. Rug plots show the locations of district absolute margins.

Figure 21: *Erststimmen* Digit Means for SPD and for CDU/CSU, 2002–2009



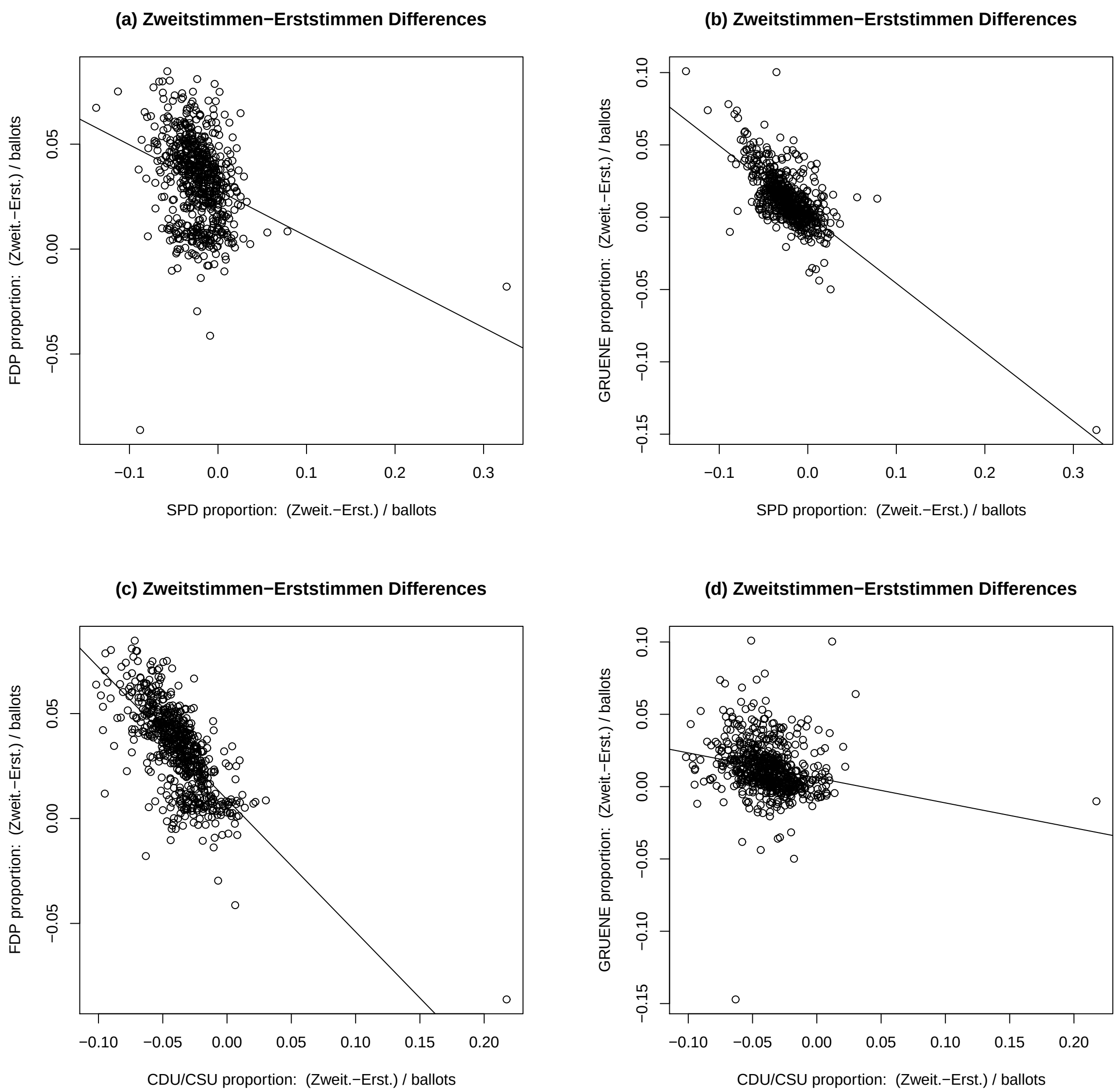
Note: Nonparametric regression contours for *Erststimmen* counts' second digits based on polling station data, using polling stations in *Wahlkreise* where SPD had most (a) or the second most (b) *Erststimmen* or CDU/CSU had the second most (c) *Erststimmen*. "Margin" is the number of *Erststimmen* for the first-place party minus the number of votes for the second-place party in each *Wahlkreis* divided by the total of *Erststimmen* cast in the *Wahlkreis*. The "SPD proportion" is the total of *Zweitstimmen* cast for SPD minus the number of *Erststimmen* cast for SPD divided by the total number of ballots used in the *Wahlkreis*. "CDU/CSU proportion" is defined analogously. Rug plots show locations of *Wahlkreis* values.

Figure 22: *Erststimmen* Digit Means for SPD and for CDU/CSU, 2002–2009



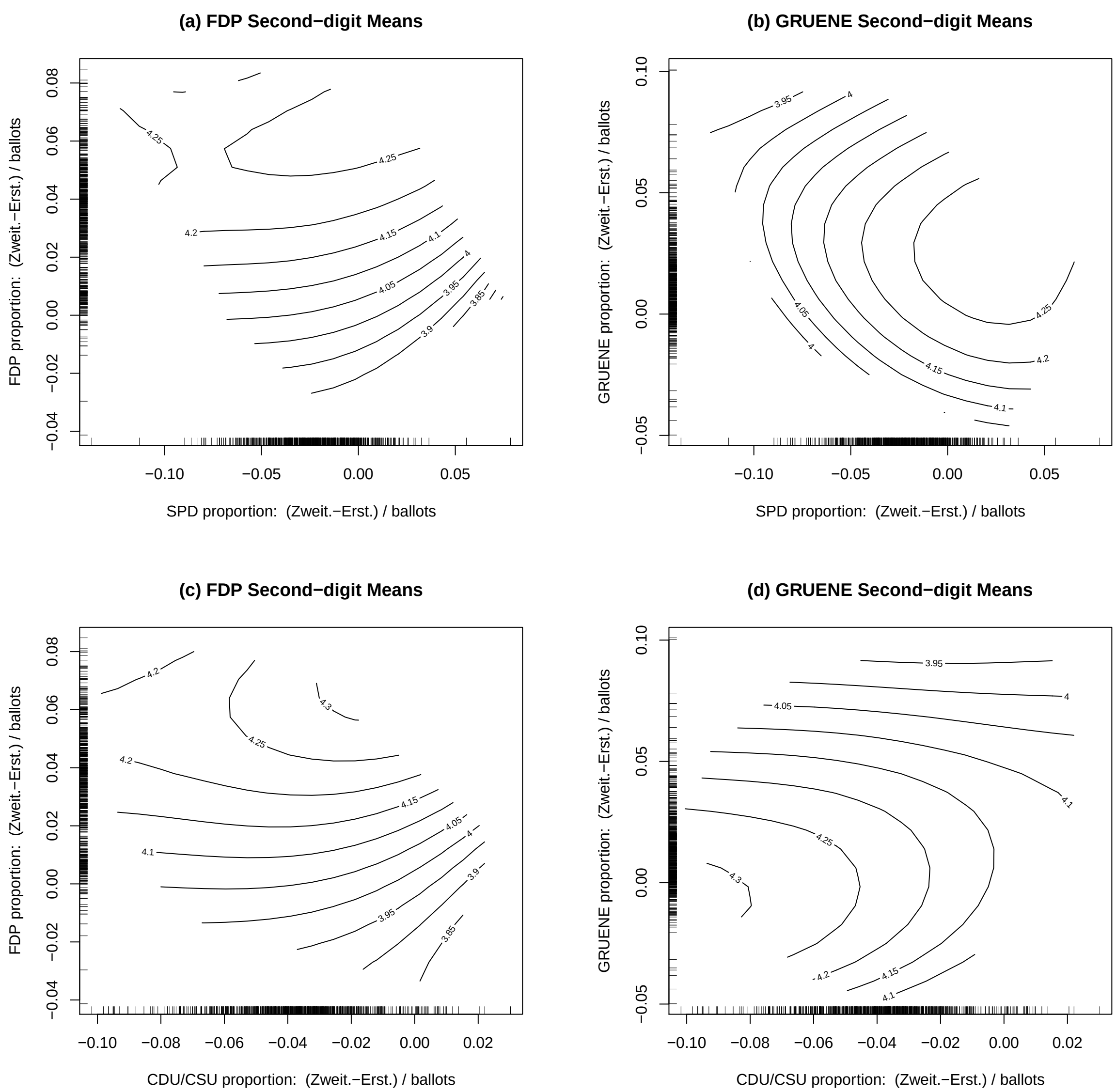
Note: Nonparametric regression contours for *Erststimmen* counts' second digits based on polling station data, using polling stations in *Wahlkreise* where either SPD or CDU/CSU had the most or the second most *Erststimmen*. "Margin" is the number of *Erststimmen* for SPD or for CDU/CSU, respectively, in each *Wahlkreis* minus the number of votes for the third-place party divided by the total of *Erststimmen* cast in the *Wahlkreis*. The "SPD proportion" is the total of *Zweitstimmen* cast for SPD minus the number of *Erststimmen* cast for SPD divided by the total number of ballots used in the *Wahlkreis*. "CDU/CSU proportion" is defined analogously. Rug plots show locations of *Wahlkreis* values.

Figure 23: *Zweitstimme* minus *Erststimme* Proportions by Wahlkreis, 1994–1998



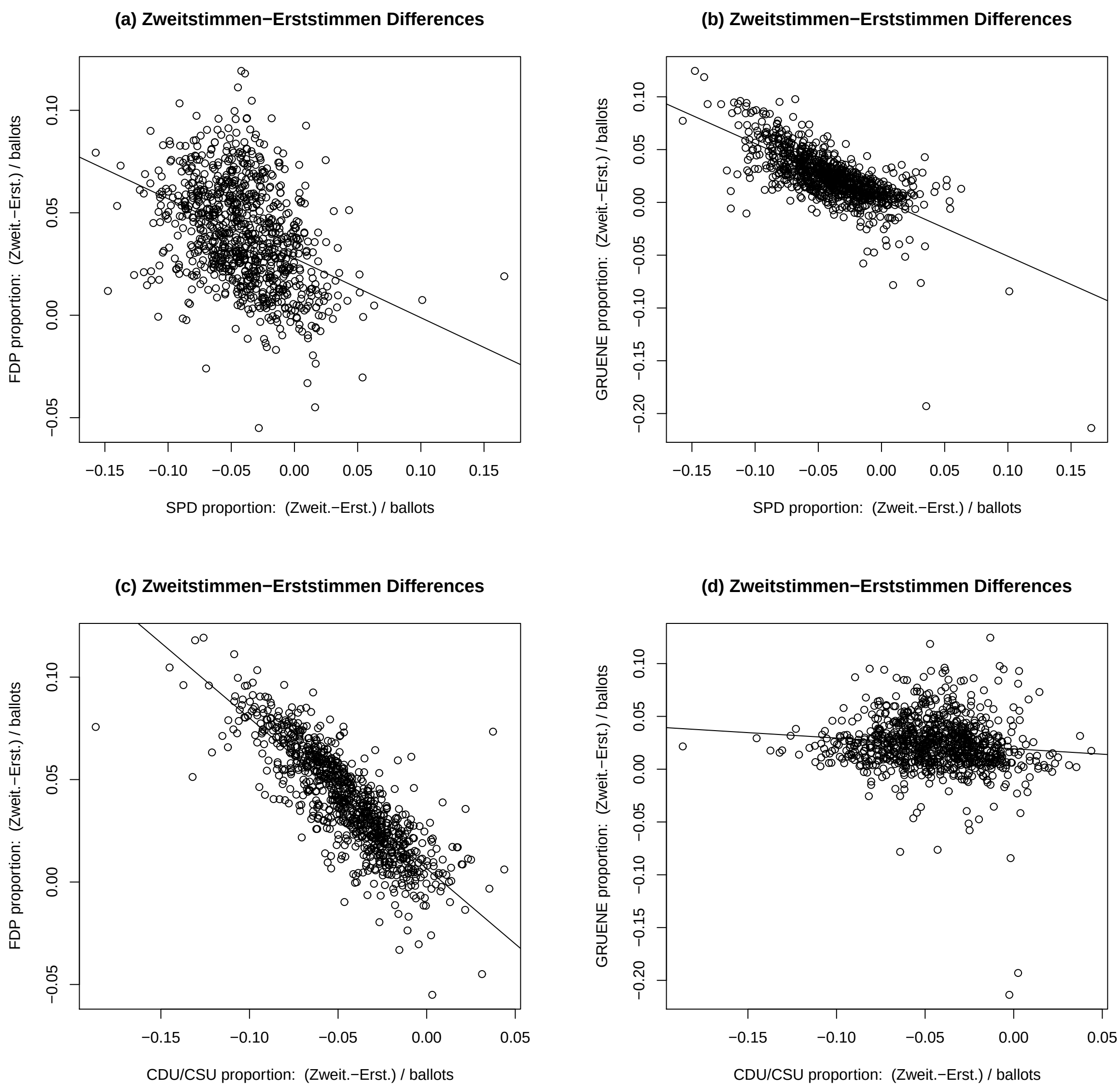
Note: The "[party] proportion" is the total of *Zweitstimmen* cast for [party] minus the number of *Erststimmen* cast for [party] divided by the total number of valid votes cast in the *Wahlkreis*. Lines indicate ordinary least squares regression slopes where the larger party is the regressor.

Figure 24: *Zweitstimme* Digit Means for FDP and Greens by SPD and CDU/CSU Switches, 1994–1998



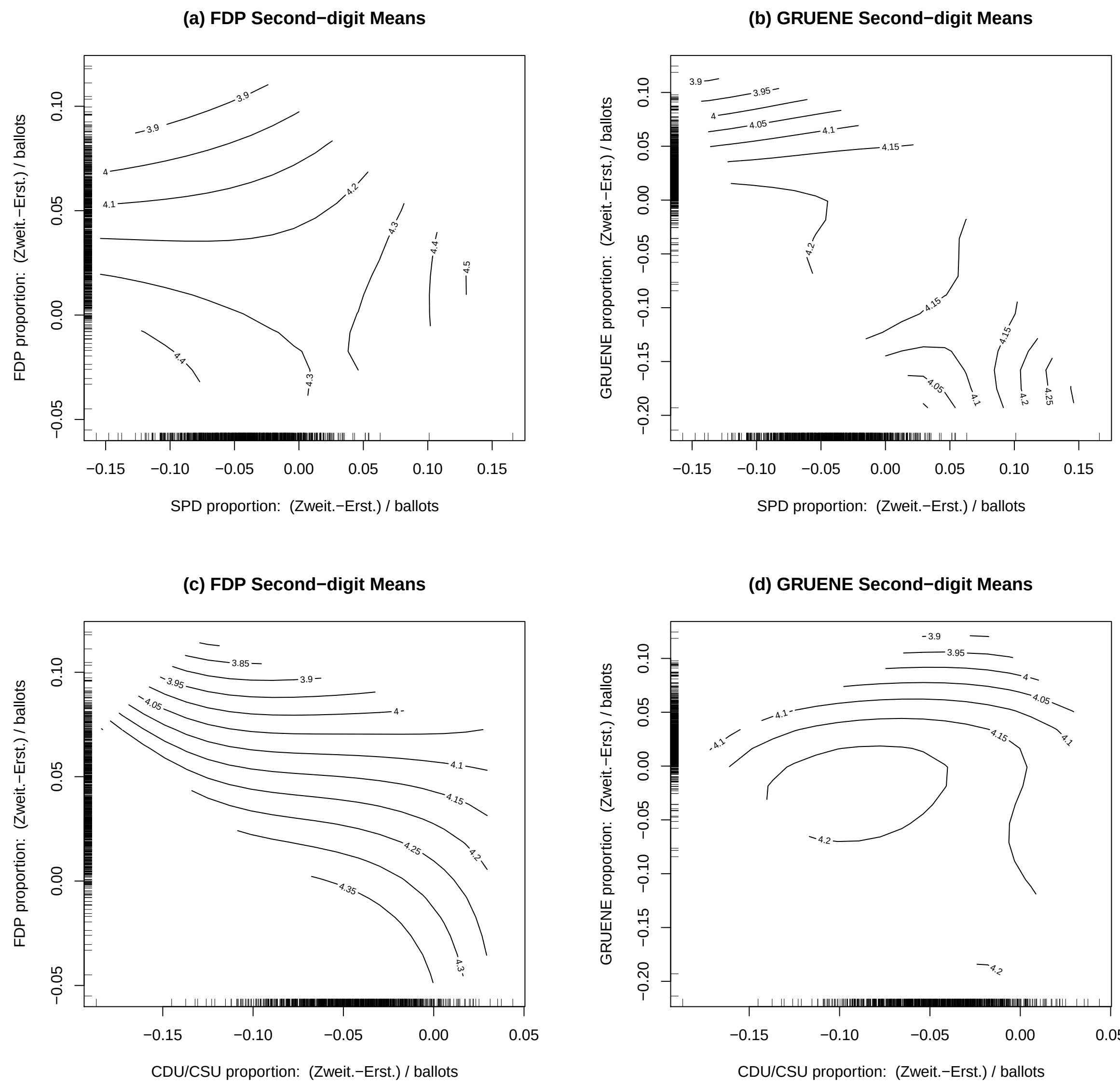
Note: Nonparametric regression contours for *Zweitstimme* counts' second digits based on polling station data. The "[party] proportion" is the total of *Zweitstimmen* cast for [party] minus the number of *Erststimmen* cast for [party] divided by the total number of ballots used in the *Wahlkreis*. Rug plots show locations of *Wahlkreis* values. Rug plots show locations of *Wahlkreis* values.

Figure 25: *Zweitstimme* minus *Erststimme* Proportions by Wahlkreis, 2002–2009



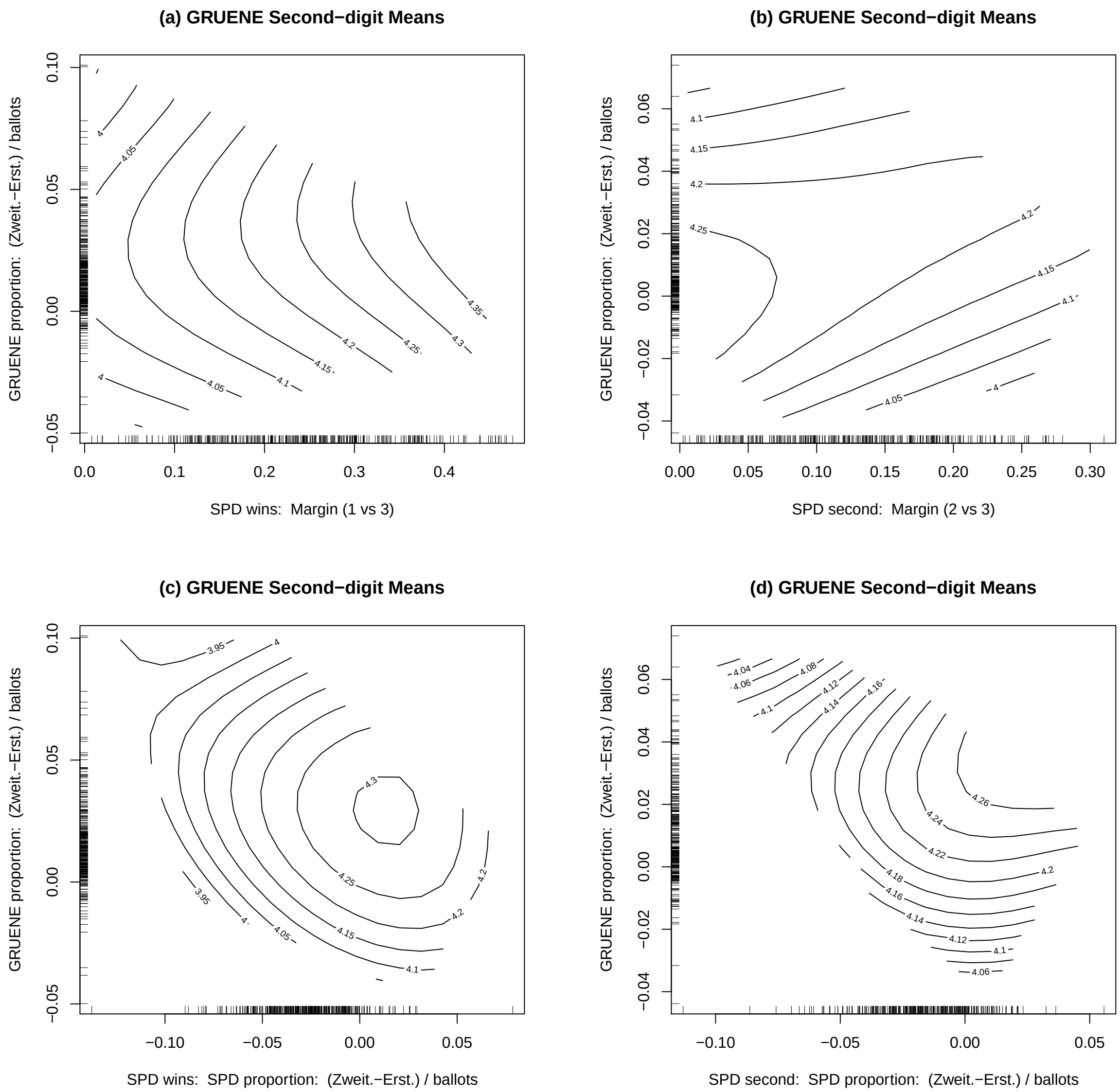
Note: The "[party] proportion" is the total of *Zweitstimmen* cast for [party] minus the number of *Erststimmen* cast for [party] divided by the total number of valid votes cast in the *Wahlkreis*. Lines indicate ordinary least squares regression slopes where the larger party is the regressor.

Figure 26: *Zweitstimme* Digit Means for FDP and Greens by SPD and CDU/CSU Switches, 2002–2009



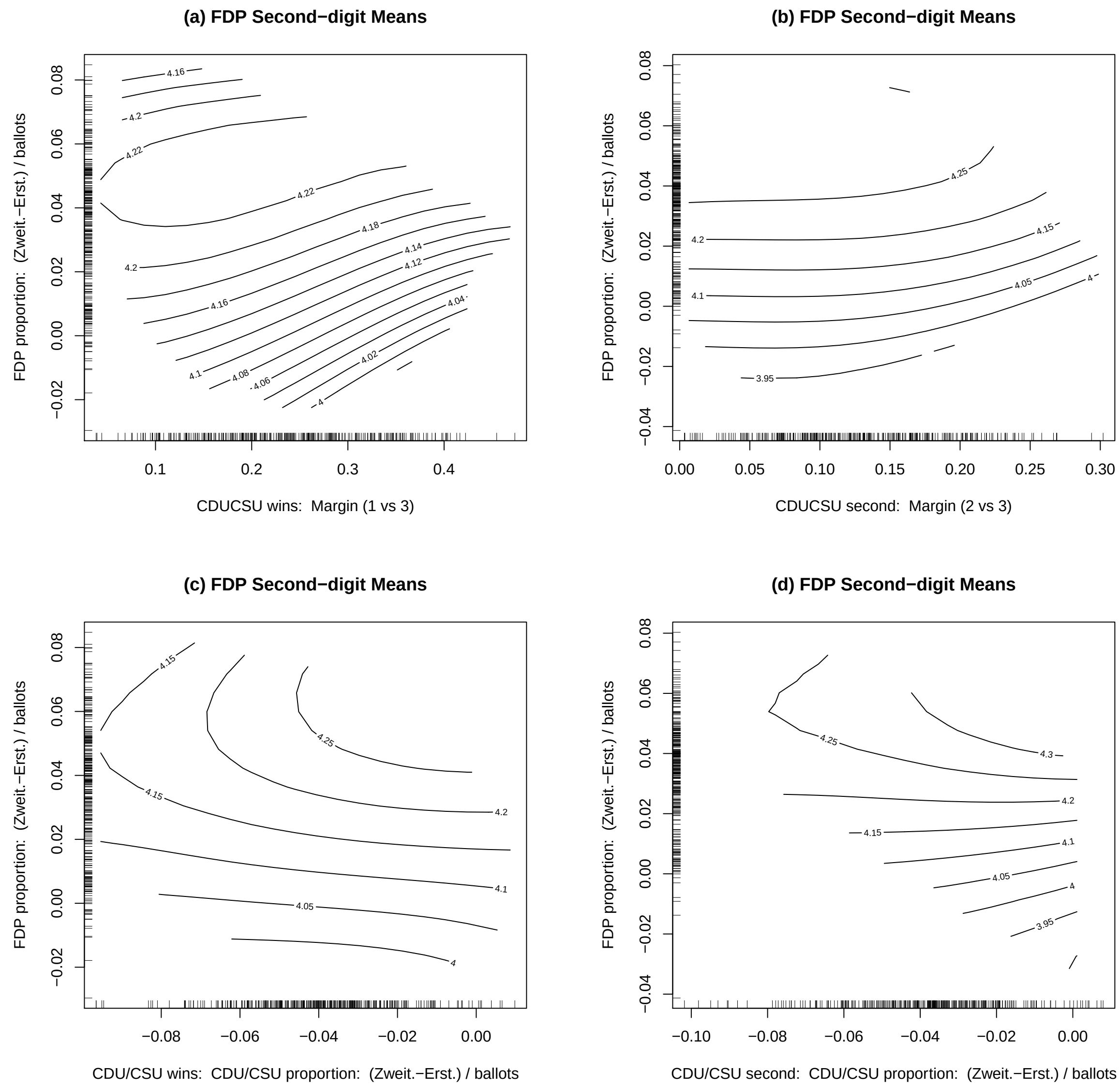
Note: Nonparametric regression contours for *Zweitstimme* counts' second digits based on polling station data. The "[party] proportion" is the total of *Zweitstimmen* cast for [party] minus the number of *Erststimmen* cast for [party] divided by the total number of ballots used in the *Wahlkreis*. Rug plots show locations of *Wahlkreis* values.

Figure 27: *Zweitstimme* Digit Means for Greens by SPD Margins, 1994–1998



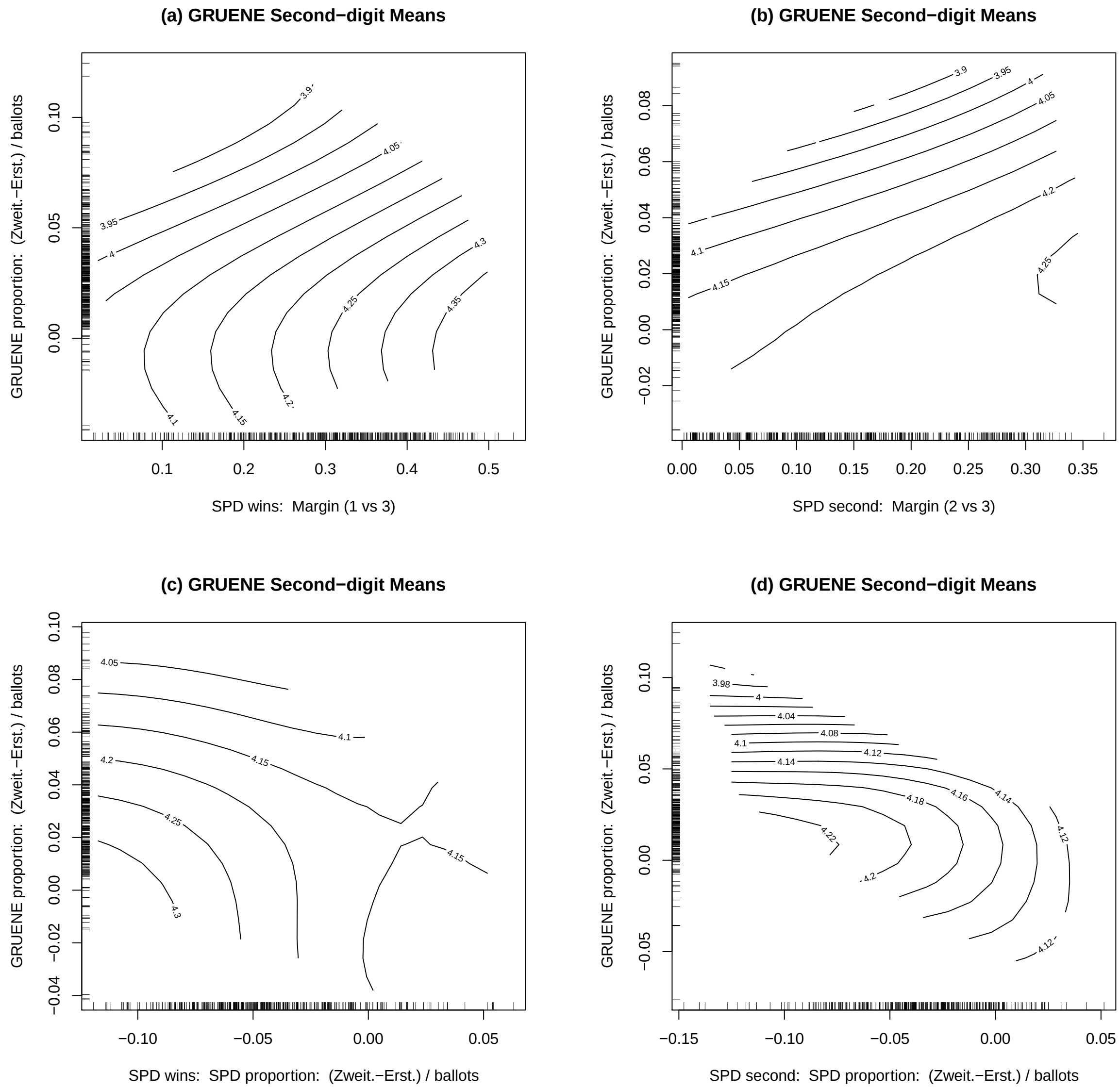
Note: Nonparametric regression contours for *Zweitstimme* counts' second digits based on polling station data, using polling stations in *Wahlkreise* where the party named as the party that "wins" (resp. "second," "third") had the most (resp. second most, third most) *Erststimmen*. "Margin" is the number of *Erststimmen* for this party in each *Wahlkreis* minus the number of votes for the third-place party divided by the total of *Erststimmen* cast in the *Wahlkreis*. The "Gruene proportion" is the total of *Zweitstimmen* cast for Greens minus the number of *Erststimmen* cast for Greens divided by the total number of valid votes cast in the *Wahlkreis*. Rug plots show locations of *Wahlkreis* values.

Figure 28: *Zweitstimme* Digit Means for FDP by CDU/CSU Margins, 1994–1998



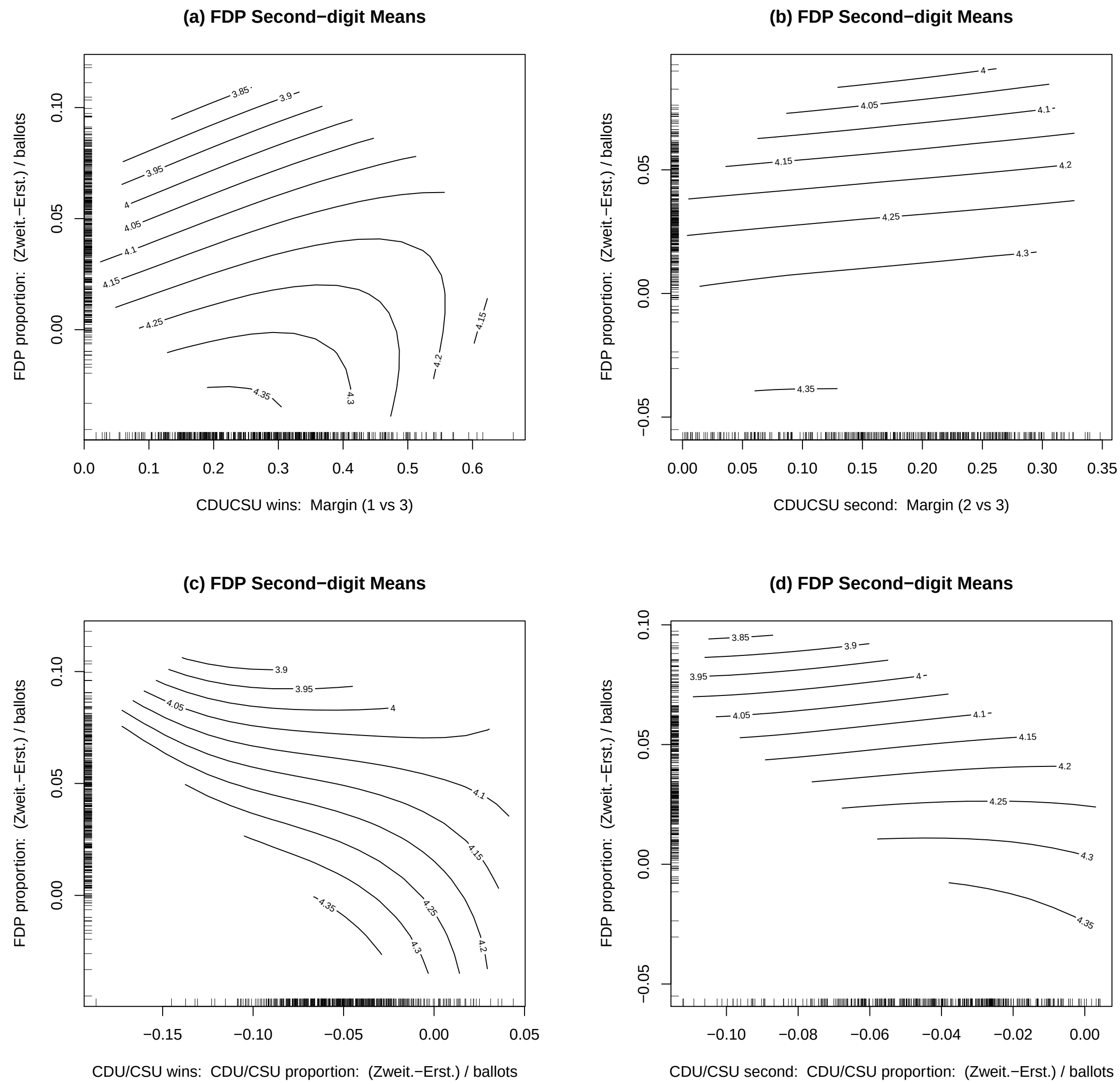
Note: Nonparametric regression contours for *Zweitstimme* counts' second digits based on polling station data, using polling stations in *Wahlkreise* where the party named as the party that "wins" (resp. "second," "third") had the most (resp. second most, third most) *Erststimmen*. "Margin" is the number of *Erststimmen* for this party in each *Wahlkreis* minus the number of votes for the third-place party divided by the total of *Erststimmen* cast in the *Wahlkreis*. The "FDP proportion" is the total of *Zweitstimmen* cast for FDP minus the number of *Erststimmen* cast for FDP divided by the total number of ballots used in the *Wahlkreis*. Rug plots show locations of *Wahlkreis* values.

Figure 29: *Zweitstimme* Digit Means for Greens by SPD Margins, 2002–2009



Note: Nonparametric regression contours for *Zweitstimme* counts' second digits based on polling station data, using polling stations in *Wahlkreise* where the party named as the party that "wins" (resp. "second," "third") had the most (resp. second most, third most) *Erststimmen*. "Margin" is the number of *Erststimmen* for this party in each *Wahlkreis* minus the number of votes for the third-place party divided by the total of *Erststimmen* cast in the *Wahlkreis*. The "Gruene proportion" is the total of *Zweitstimmen* cast for Greens minus the number of *Erststimmen* cast for Greens divided by the total number of valid votes cast in the *Wahlkreis*. Rug plots show locations of *Wahlkreis* values.

Figure 30: *Zweitstimme* Digit Means for FDP by CDU/CSU Margins, 2002–2009



Note: Nonparametric regression contours for *Zweitstimme* counts' second digits based on polling station data, using polling stations in *Wahlkreise* where the party named as the party that "wins" (resp. "second," "third") had the most (resp. second most, third most) *Erststimmen*. "Margin" is the number of *Erststimmen* for this party in each *Wahlkreis* minus the number of votes for the third-place party divided by the total of *Erststimmen* cast in the *Wahlkreis*. The "FDP proportion" is the total of *Zweitstimmen* cast for FDP minus the number of *Erststimmen* cast for FDP divided by the total number of ballots used in the *Wahlkreis*. Rug plots show locations of *Wahlkreis* values.

Table 15: State Parliament Election Statistics, Baden-Würtemberg, 2001–2011

			vote count				proportion
Year	Electors	Turnout	SPD	CDU	FDP	Green	Green
2001	7,313,844	.63	1,508,358	2,029,806	367,580	350,383	.077
2006	7,516,919	.53	996,207	1,748,766	421,994	462,889	.117
2011	7,622,873	.66	1,152,594	1,943,912	262,784	1,206,182	.242

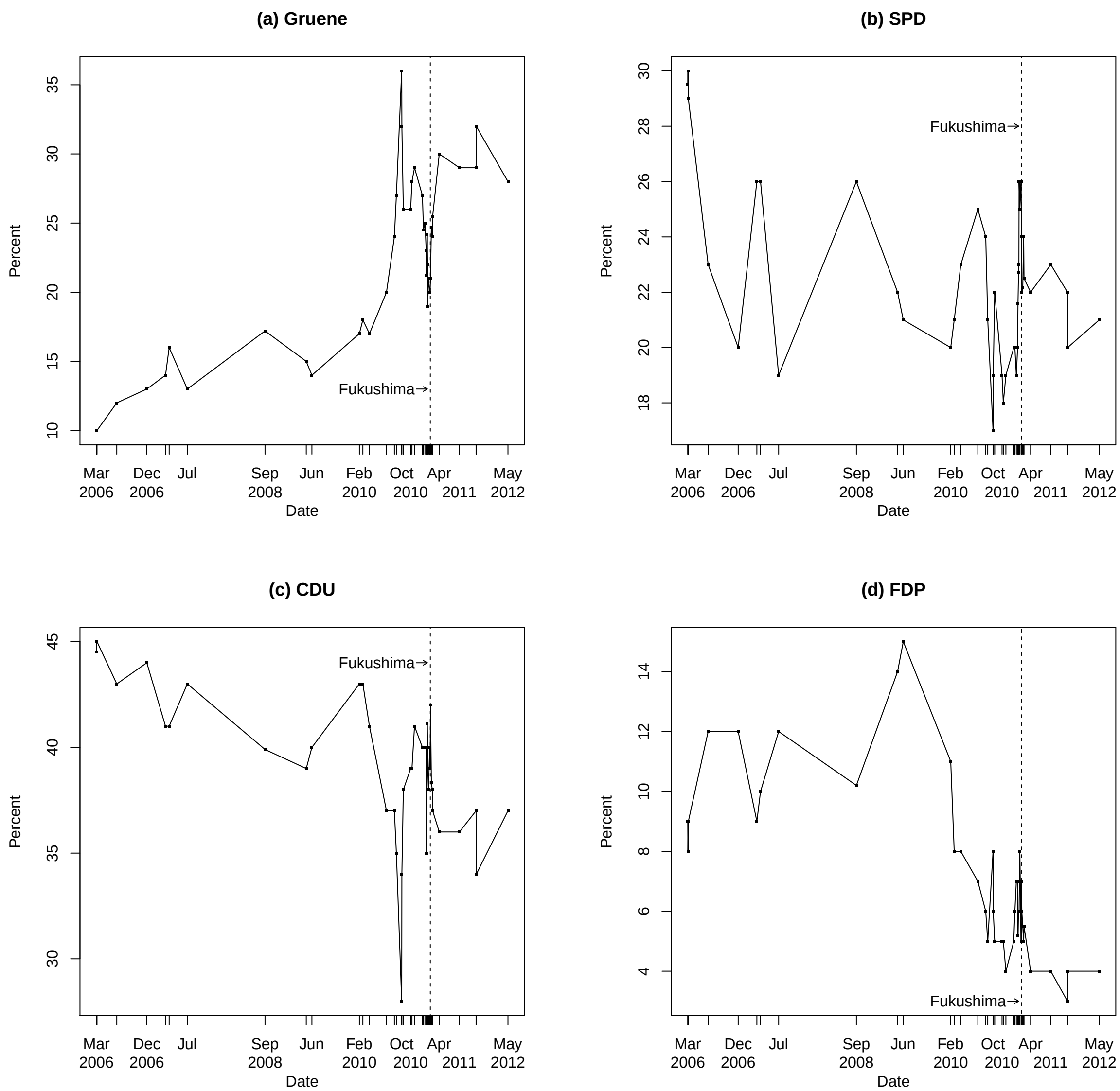
Source: "Constituency results of the parliamentary elections" (Baden-Württemberg 2012).

Table 16: State Parliament Elections, Baden-Würtemberg, 2001–2011: χ^2_{2BL} and $\hat{j}$ Statistics

Type	Party	N	χ^2_{2BL}	$\hat{\alpha}$	$\hat{j}$	$\hat{j}_{\text{lo}}$	$\hat{j}_{\text{hi}}$
2001	SPD	10,367	21.16	0.13	4.13	4.08	4.19
	CDU	10,417	23.29	0.07	4.26	4.20	4.31
	FDP	9,432	14.11	0.41	4.26	4.21	4.32
	Green	9,095	7.62	0.46	4.23	4.17	4.29
2006	SPD	10,230	209.13	0.00	3.79	3.73	3.85
	CDU	10,376	21.71	0.11	4.16	4.10	4.21
	FDP	9,731	27.49	0.02	4.33	4.27	4.38
	Green	9,464	8.46	0.49	4.23	4.18	4.29
2011	SPD	10,328	188.23	0.00	3.82	3.77	3.88
	CDU	10,419	12.00	0.47	4.22	4.16	4.27
	FDP	8,845	6.69	0.42	4.23	4.17	4.29
	Green	10,353	94.25	0.00	3.92	3.87	3.98

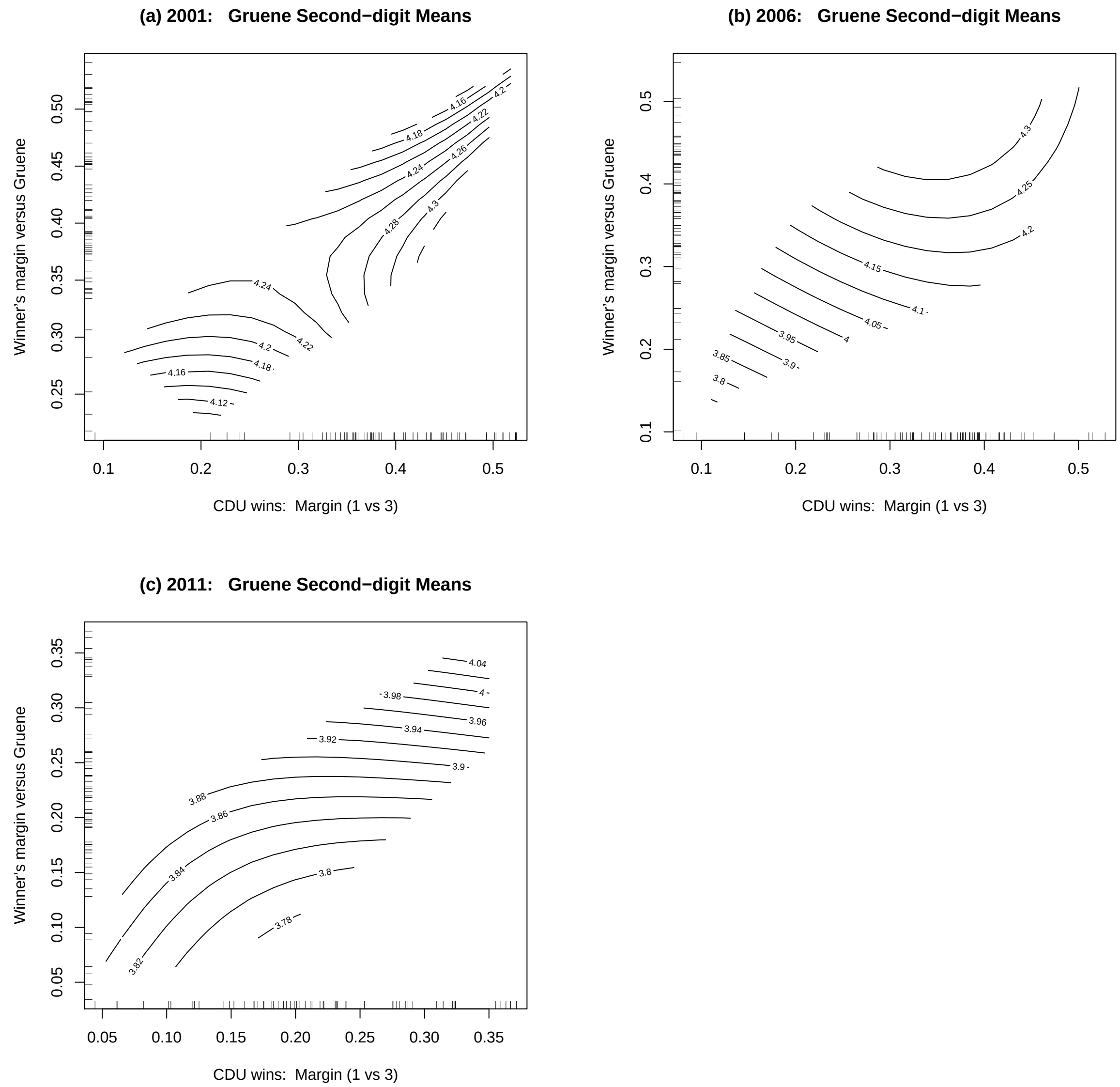
Notes: Statistics for precinct vote counts. N is the number of polling stations with a vote count > 9. $\hat{\alpha} = (1 + [-ep\log(p)]^{-1})^{-1}$ where p is the p-value of χ^2_{2BL} (Sellke, Bayarri and Berger 2001). $\hat{j}$ is the second-digit mean. $\hat{j}_{\text{lo}}$ and $\hat{j}_{\text{hi}}$ are the lower and upper bounds of the 95% confidence interval for $\hat{j}$.
Data source: (Baden-Württemberg 2012).

Figure 31: Baden-Württemberg 2006–2012: Vote Preference Polls



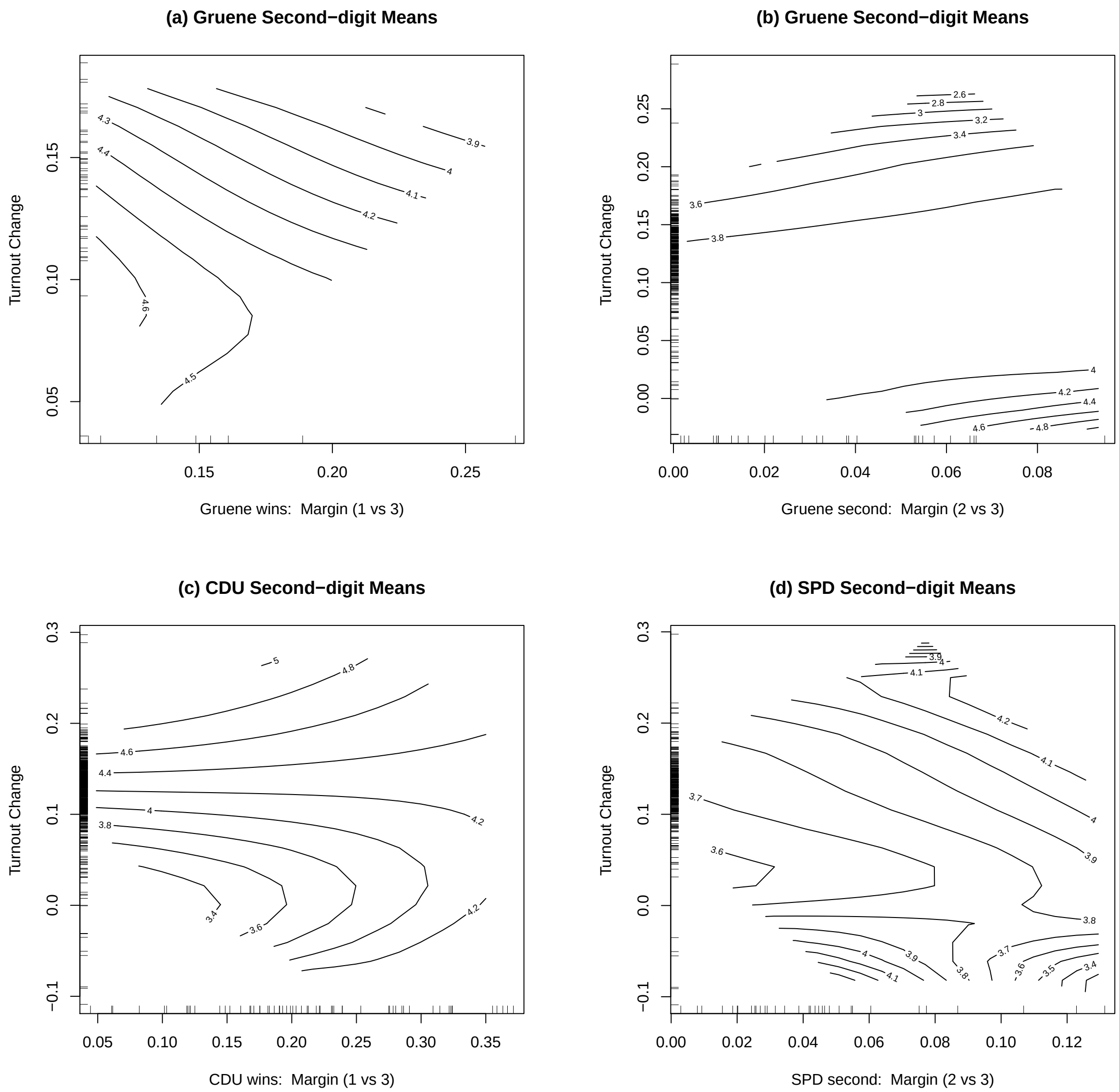
Source: "Umfragen Baden-Württemberg [Umfragen Landtagswahlen]," (Cantow et al. 2012). Note: Responses to survey question, "Wenn am nächsten Sonntag Landtagswahl wäre ..." (If you knew the state election next Sunday ...).

Figure 32: Baden-Württemberg 2001–2011: Vote Count Digit Means for Green



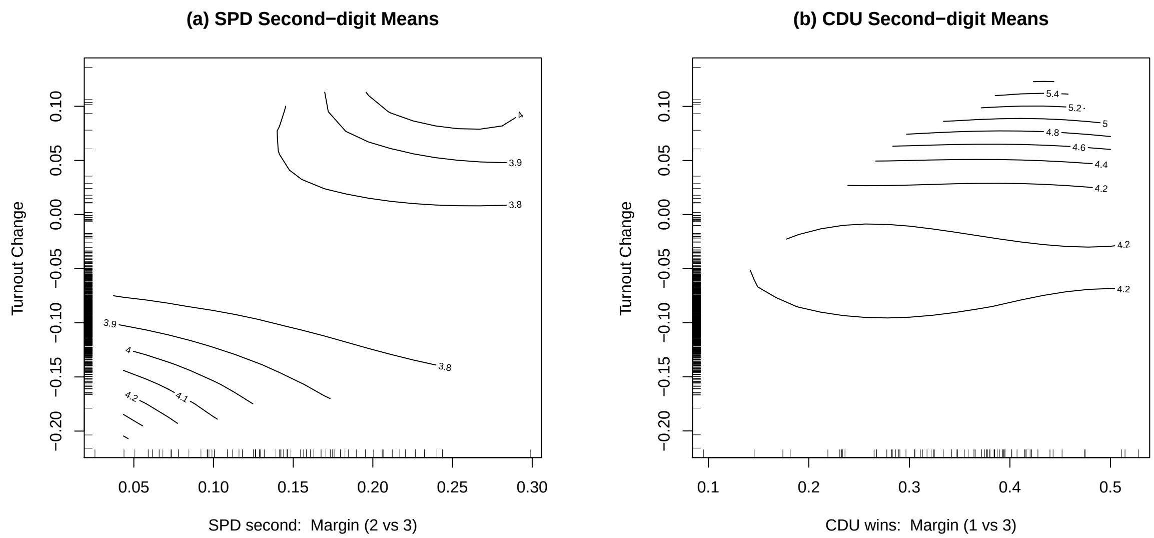
Note: Nonparametric regression contours for vote counts' second digits based on polling station data. The "Winner's margin versus Gruene" is the total of votes cast for the winning party minus the number of votes cast for Green divided by the total number of valid votes cast in the *Wahlkreis*. Rug plots show locations of *Wahlkreis* values.

Figure 33: Baden-Württemberg 2011: Vote Count Digit Means by Margins and Changes in Turnout



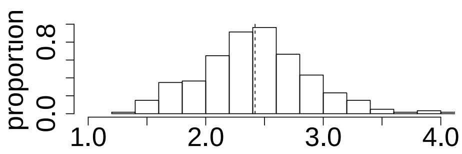
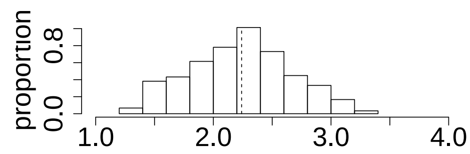
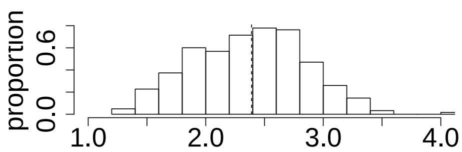
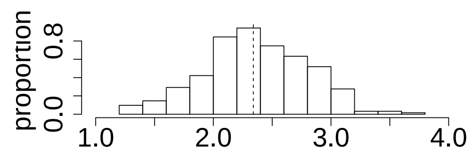
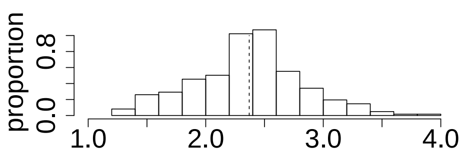
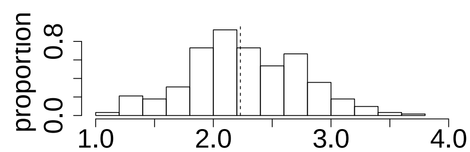
Note: Nonparametric regression contours for vote counts' second digits based on polling station data. "Turnout Change" is *Gemeinde*-specific turnout in 2011 minus *Gemeinde*-specific turnout in 2006. Rug plots for "Turnout Change" show locations of the *Gemeinde*-specific values. Rug plots for $\mathfrak{M}_{13}$ and $\mathfrak{M}_{23}$ show locations of *Wahlkreis* values.

Figure 34: Baden-Württemberg 2006: Vote Count Digit Means by Margins and Changes in Turnout



Note: Nonparametric regression contours for vote counts' second digits based on polling station data. "Turnout Change" is *Gemeinde*-specific turnout in 2006 minus *Gemeinde*-specific turnout in 2006. Rug plots for "Turnout Change" show locations of the *Gemeinde*-specific values. Rug plots for $\mathfrak{M}_{13}$ and $\mathfrak{M}_{23}$ show locations of *Wahlkreis* values.

Table 17: Canadian Federal Elections, 1997–2011: Effective Number of Parties per Riding

Year	Distribution of N_p	Year	Distribution of N_p
1997		2000	
2004		2006	
2008		2011	

Note: N_p is the effective number of parties (Golosov 2010). Dashed vertical lines show location of median value in each year. Median and standard deviation in each year: 1997, (2.42, .47); 2000, (2.24, .44); 2004, (2.39, .48); 2006, (2.34, .44); 2008, (2.37, .46); 2011, (2.23, .48). Data source: Elections Canada (2006*c*,*a*,*b*, 2010, 2012).

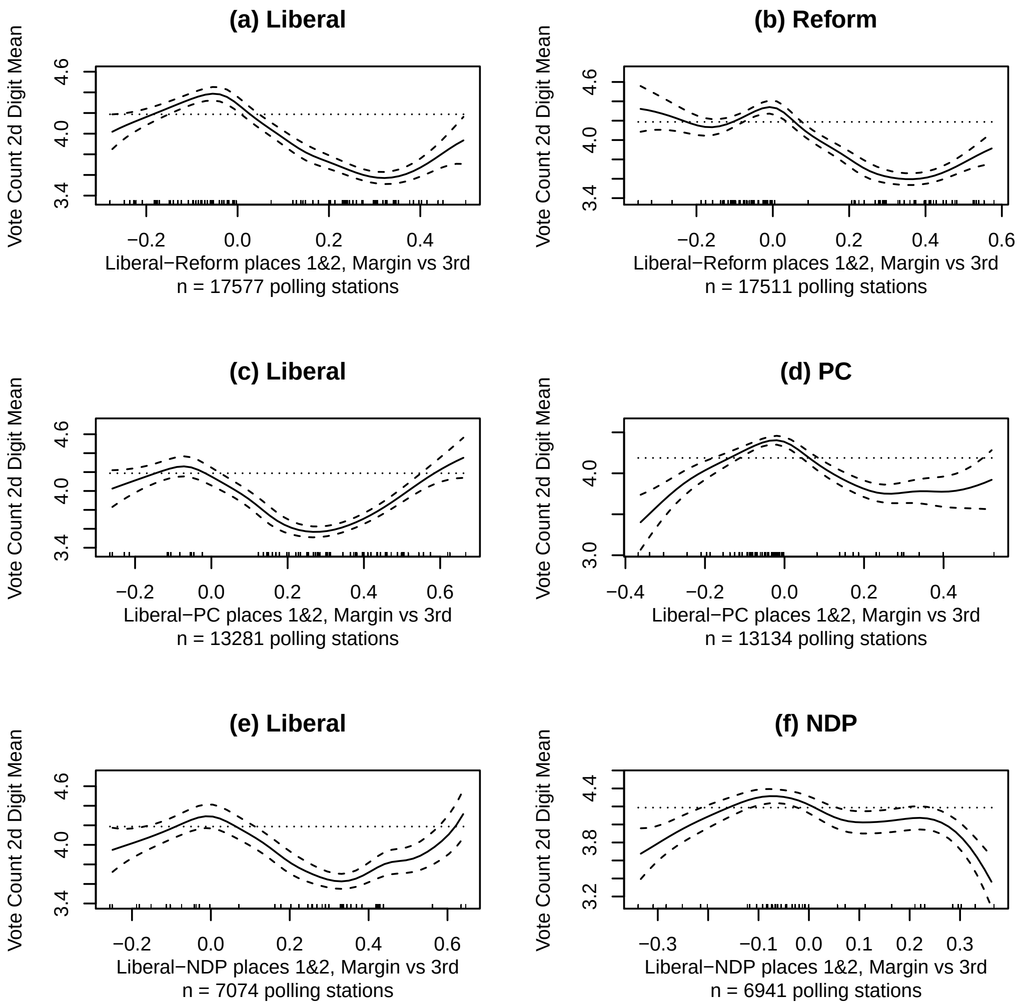
Table 18: Canadian Federal Elections, 1997–2011: Vote Counts

	Overall Total of Votes					
Party	1997	2000	2004	2006	2008	2011
Liberal	4,975,425	5,252,031	4,627,892	4,479,415	3,611,767	2,767,213
Reform/Alliance[a]	2,515,993	3,276,929	—[b]	—[b]	—[b]	—[b]
Progressive Conservative	2,450,816	1,566,998	—[b]	—[b]	—[b]	—[b]
Conservative	—[b]	—[b]	3,736,203	5,374,071	5,188,497	5,807,385
NDP	1,442,422	1,093,213	2,015,758	2,589,597	2,488,130	4,465,827
Bloc Québécois	1,368,778	1,356,859	1,574,372	1,553,201	1,377,771	880,817
Green Party	55,583	104,402	609,134	664,068	932,580	569,189

	Median of Votes per Riding[c]					
Party	1997	2000	2004	2006	2008	2011
Liberal	16,317	18,198	14,268	13,960	10,396	7,273
Reform/Alliance[a]	9,229	8,704	—[b]	—[b]	—[b]	—[b]
Progressive Conservative	7,879	4,218	—[b]	—[b]	—[b]	—[b]
Conservative	—[b]	—[b]	11,555	16,180	16,318	19,000
NDP	3,255	2,365	5,417	6,830	6,542	12,499
Bloc Québécois	18,528	18,886	22,215	21,093	19,085	12,504
Green Party	577	776	1,771	1,916	2,618	1,505

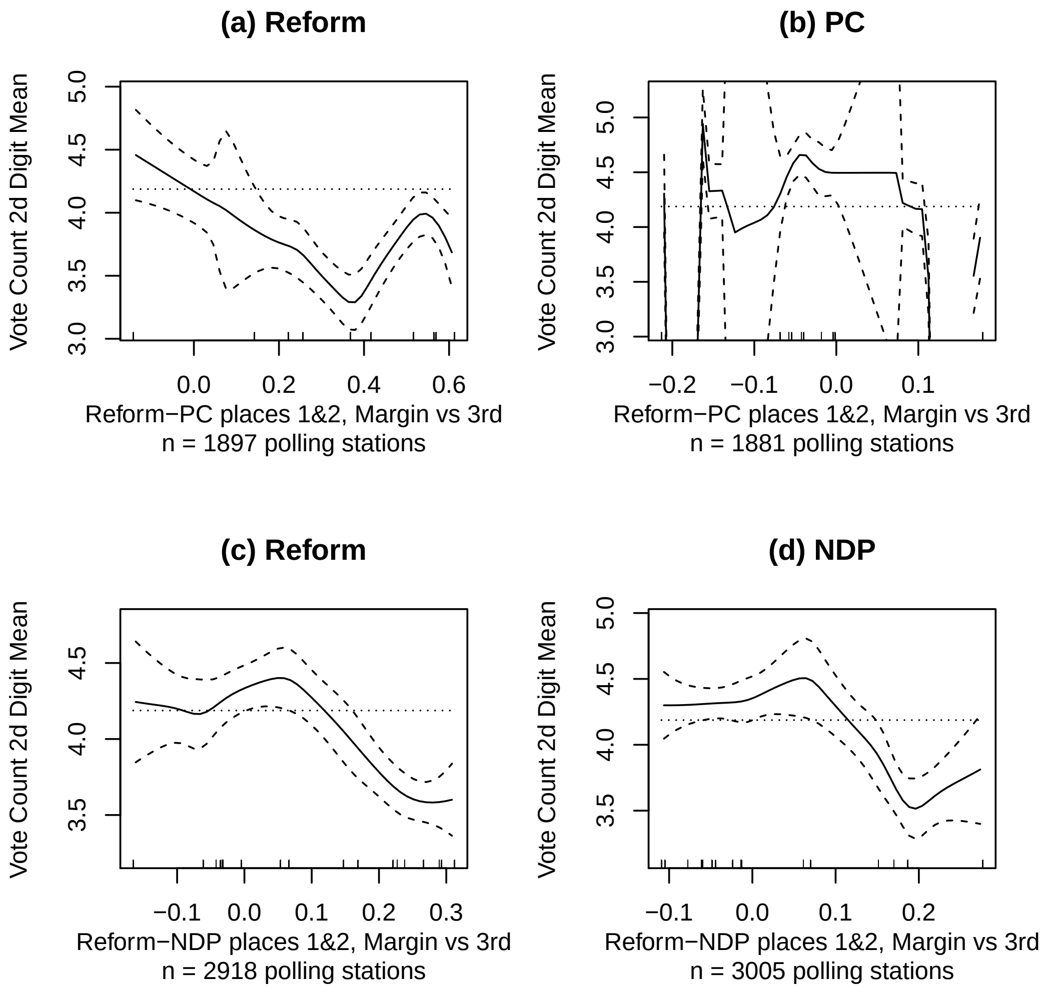
Notes: [a] Reform in 1997, Canadian Alliance in 2000; [b] party does not exist in this year; [c] using only ridings where a party's candidate was on the ballot. Data source: Elections Canada (2006*c*,*a*,*b*, 2010, 2012).

Figure 35: Canada 1997: Polling Station Count Second-digit Mean by $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$



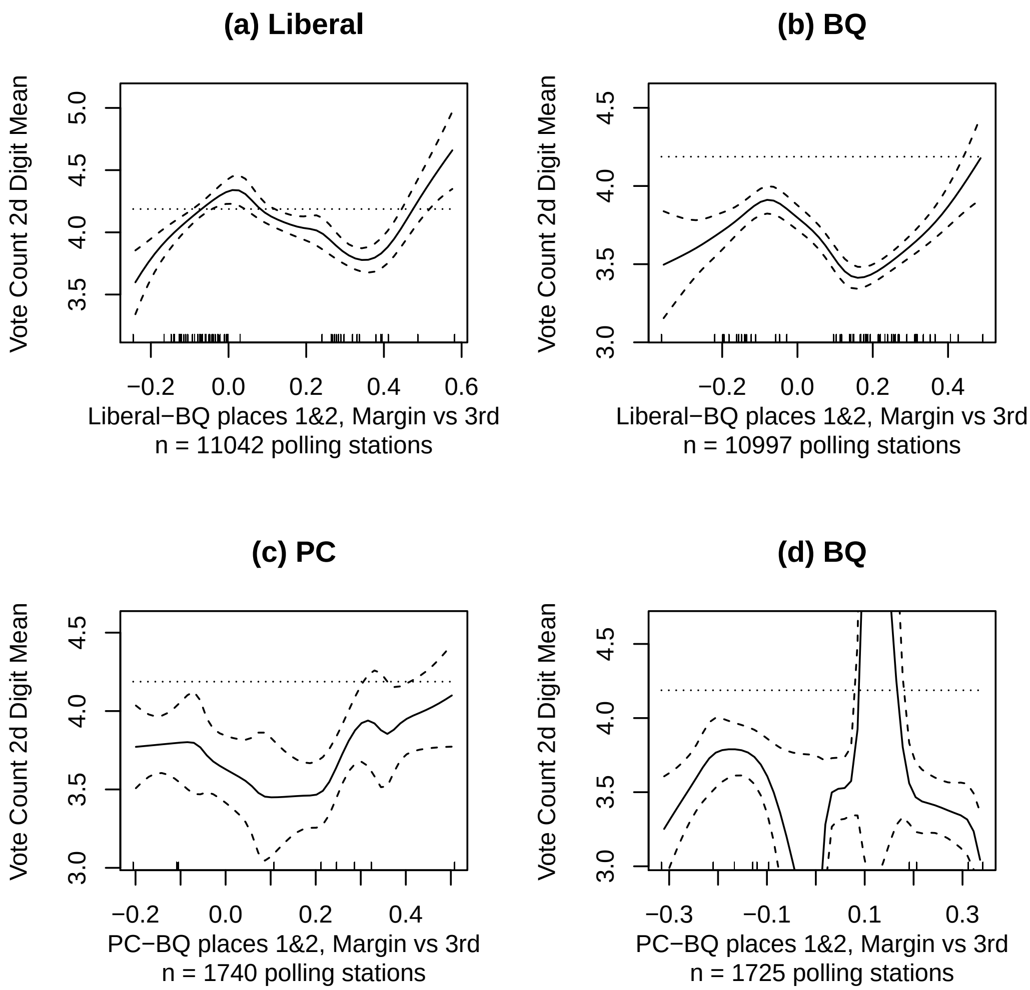
Note: Nonparametric regression of vote counts' second digits based on polling station data. Rug plots show locations of riding values of $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$.

Figure 36: Canada 1997: Polling Station Count Second-digit Mean by $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$



Note: Nonparametric regression of vote counts' second digits based on polling station data. Rug plots show locations of riding values of $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$.

Figure 37: Canada 1997: Polling Station Count Second-digit Mean by $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$



Note: Nonparametric regression of vote counts' second digits based on polling station data. Rug plots show locations of riding values of $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$.

Table 19: Mexican Federal Elections, 1994–2012: *Presidente*, Vote Counts

Overall Total of Votes

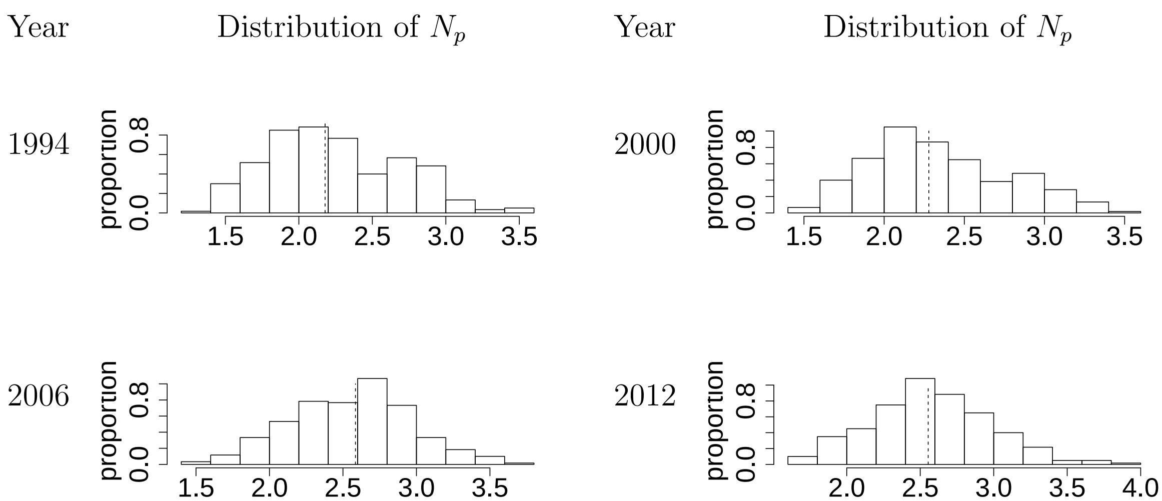
Party	1994	Party	2000	Party	2006	Party	2012
PAN	9,223,255	CAC	15,989,832	PAN	15,000,284	PAN	12,786,647
PRI	17,353,605	PRI	13,579,914	APM	9,301,441	CM	19,226,784
PRD	5,915,617	CAM	6,256,810	PBT	14,756,350	MP	15,896,999
PVEM	330,098	PCD	206,593	NA	401,804	NA	1,150,662
PT	977,395	PARM	156,896	ASDC	1,128,850		
PARM	194,634	DSPPN	592,384				
PPS	168,022						
PRN	300,974						
PDM	98,842						

Median of Votes per District

Party	1994	Party	2000	Party	2006	Party	2012
PAN	25,328.0	CAC	52,708.5	PAN	47,825.5	PAN	40,140.5
PRI	54,556.0	PRI	43,428.5	APM	30,754.0	CM	61,597.0
PRD	15,821.0	CAM	17,677.0	PBT	44,180.5	MP	48,193.5
PVEM	724.5	PCD	587.0	NA	1,198.0	NA	3,570.0
PT	2,286.5	PARM	459.0	ASDC	3,687.5		
PARM	525.0	DSPPN	1,506.5				
PPS	440.5						
PRN	709.5						
PDM	190.0						

Notes: Data source: Instituto Federal Electoral (2007*a*,*b*, 2006, 2012*d*).

Figure 38: Mexican Federal Elections, 1994–2012: *Diputados Federales, Mayoría Relativa*, Effective Number of Parties per District



Note: N_p is the effective number of parties (Golosov 2010). Dashed vertical lines show location of median value in each year. Median and standard deviation in each year: 1994, (2.18, .45); 2000, (2.23, .43); 2006, (2.59, .41); 2012, (2.55, .42). Data source: Instituto Federal Electoral (2007*a*,*b*, 2006, 2012*d*).

Table 20: Mexican Federal Elections, 1994–2012: *Diputados Federales, Mayoría Relativa*, Vote Counts

Overall Total of Votes

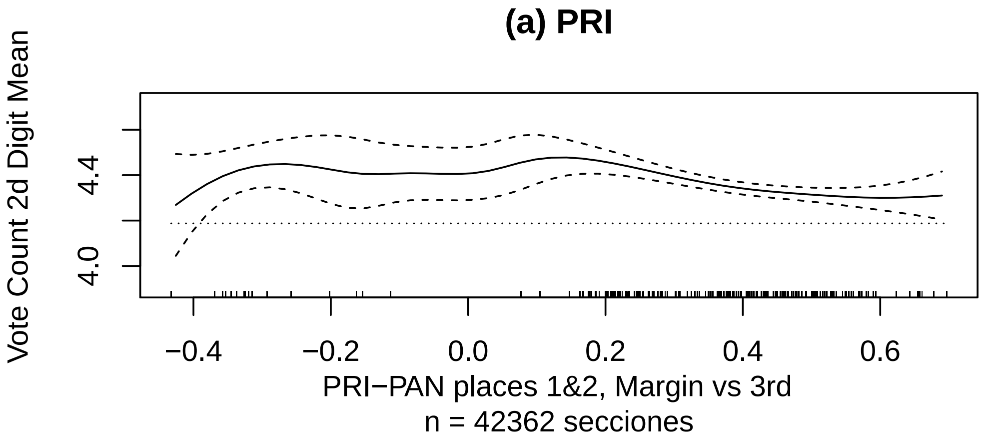
Party	1994	Party	2000	Party	2006	Party	2012
PAN	8,801,957	CAC	14,228,283	PAN	13,784,935	PAN	12,895,902
PRI	17,177,620	PRI	13,739,305	APM	11,647,697	PRI	5,378,339
PRD	5,717,685	CAM	6,951,289	PBT	11,969,049	CM	12,827,080
PVEM	477,256	PCD	427,626	NA	1,876,443	MP	13,358,045
PT	907,221	PARM	272,024	ASDC	847,599	PVEM	729,819
PARM	289,437	DSPPN	699,469			NA	2,033,159
PPS	235,036						
PRN	386,619						
PDM	150,811						

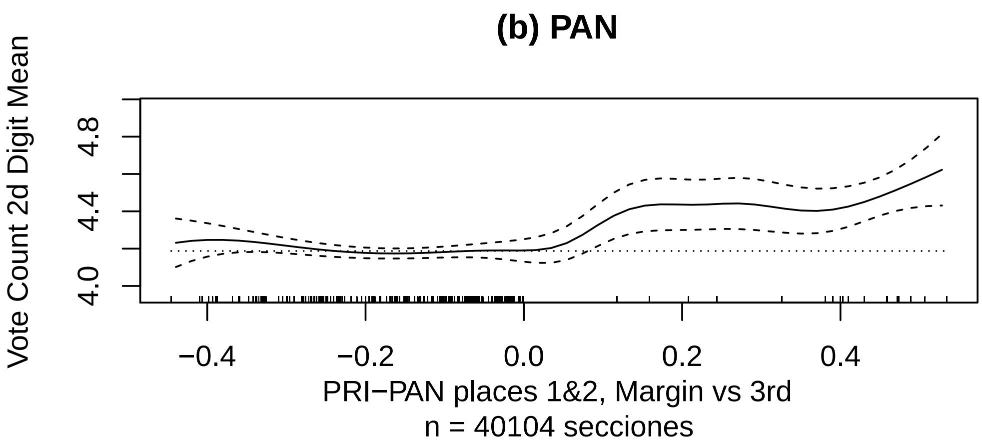
Median of Votes per District[a]

Party	1994	Party	2000	Party	2006	Party	2012
PAN	23,946.0	CAC	46,959.5	PAN	44,279.0	PAN	42,119.5
PRI	55,314.0	PRI	44,580.5	APM	38,815.0	PRI	52,060.0
PRD	14,975.0	CAM	19,280.5	PBT	35,328.0	CM	64,040.0
PVEM	932.0	PCD	984.5	NA	6,192.5	MP	39,573.0
PT	1,997.5	PARM	725.5	ASDC	2,118.0	PVEM	5,464.0
PARM	663.0	DSPPN	1,449.5			NA	5,659.5
PPS	589.0						
PRN	952.0						
PDM	270.0						

Notes: [a] using only districts where a party's candidate was on the ballot. Data source: Instituto Federal Electoral (2007*a*,*b*, 2006, 2012*d*).

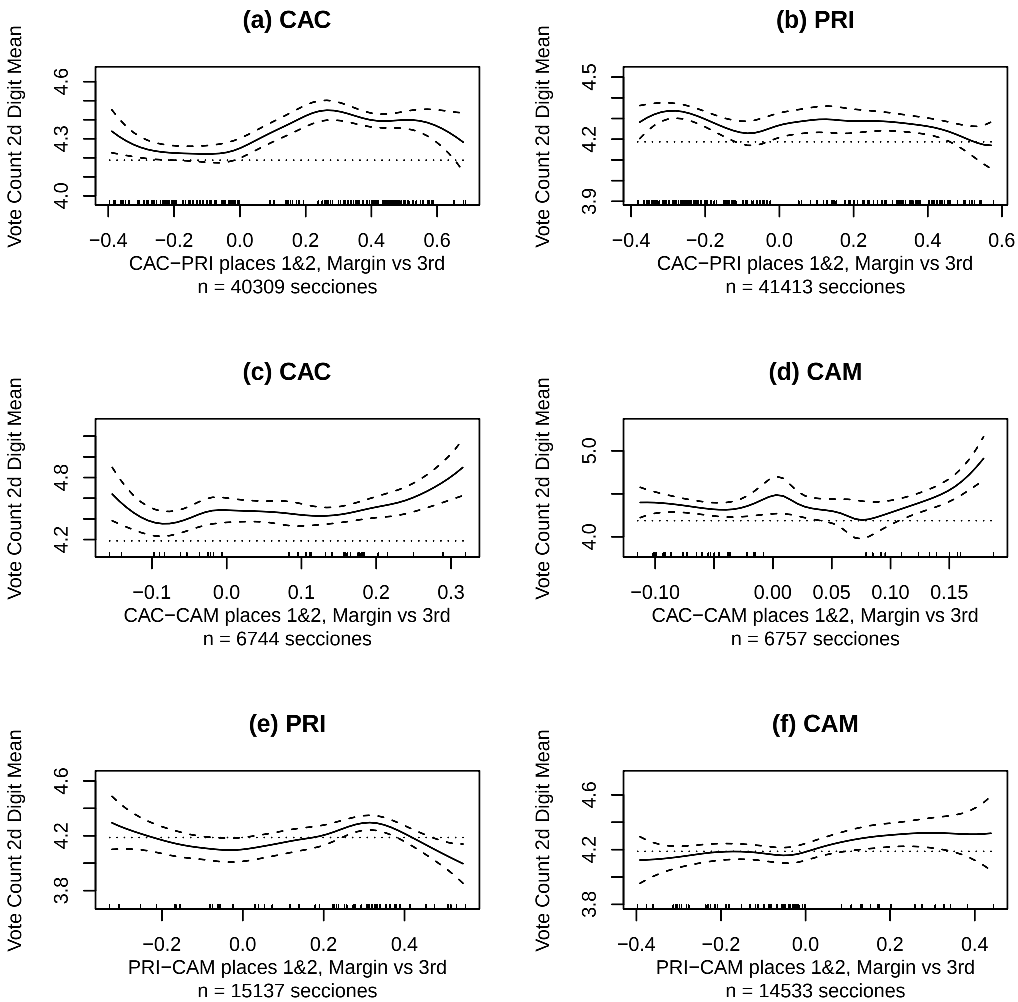
Figure 39: Mexico 1994: *Diputados*, *Sección* Count Second-digit Mean (Districts) by $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$





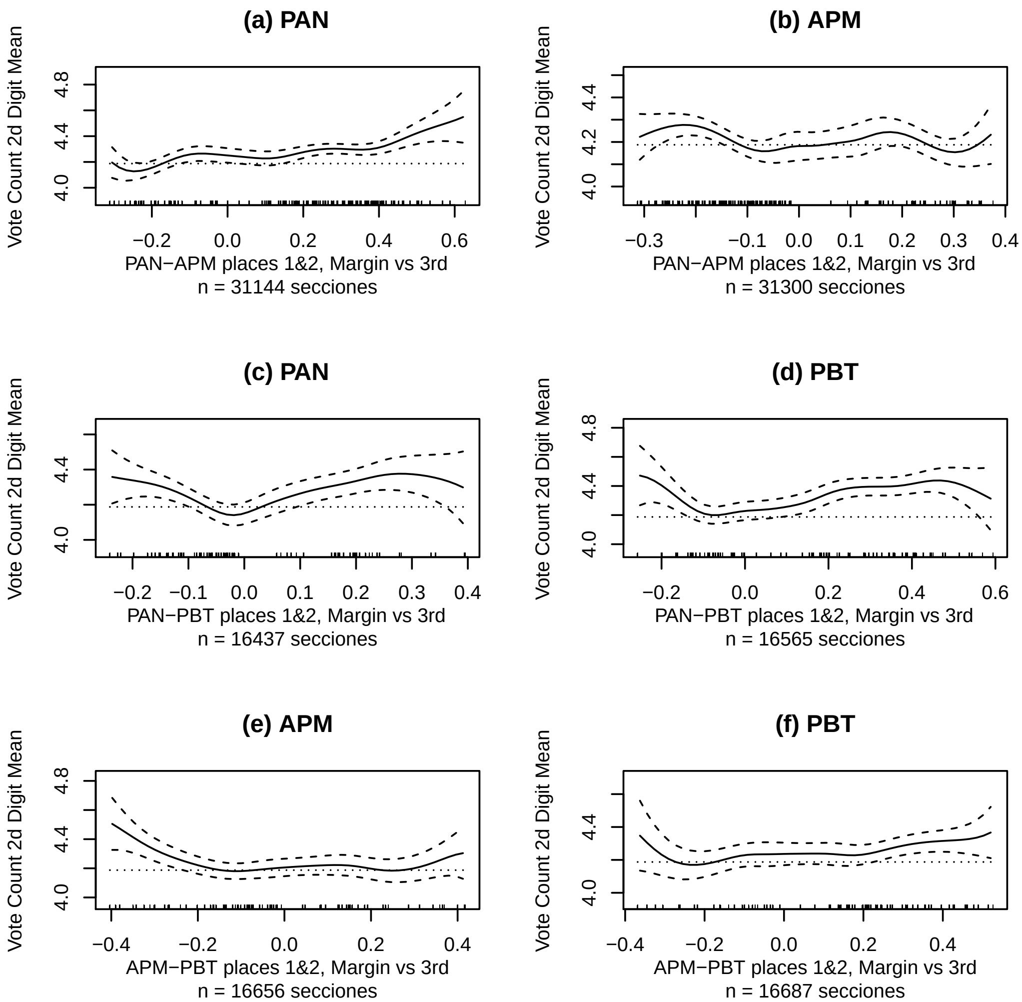
Note: Nonparametric regression of *Mayoría Relativa* vote counts' second digits based on *secciòn* data. Rug plots show locations of *secciòn* values of $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$.

Figure 40: Mexico 2000: *Diputados*, *Sección* Count Second-digit Mean (Districts) by $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$



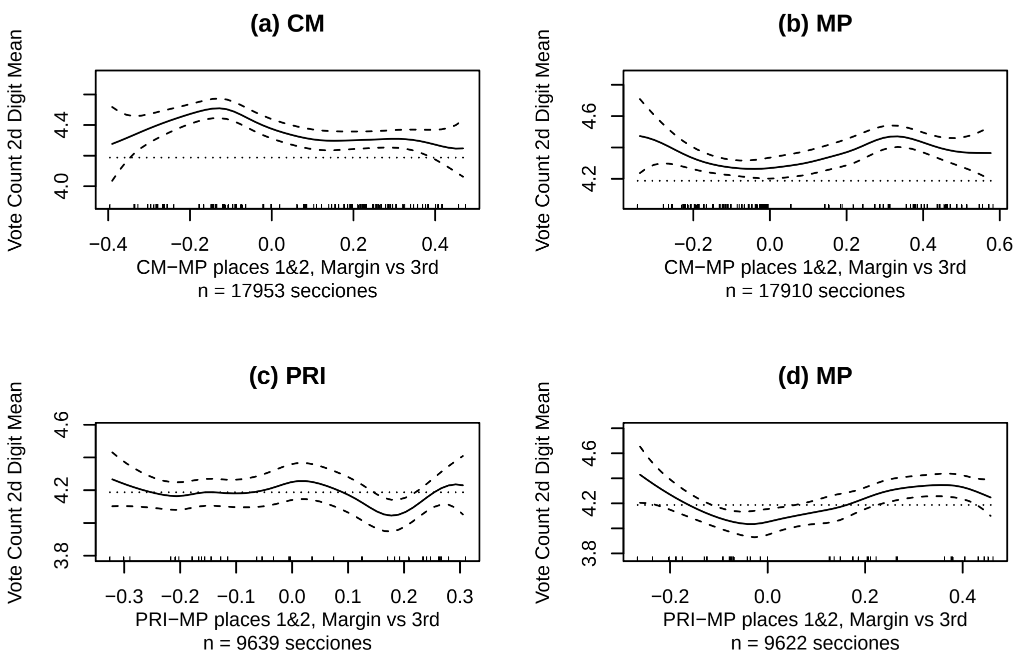
Note: Nonparametric regression of *Mayoría Relativa* vote counts' second digits based on *secciòn* data. Rug plots show locations of *secciòn* values of $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$.

Figure 41: Mexico 2006: *Diputados*, *Sección* Count Second-digit Mean (Districts) by $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$



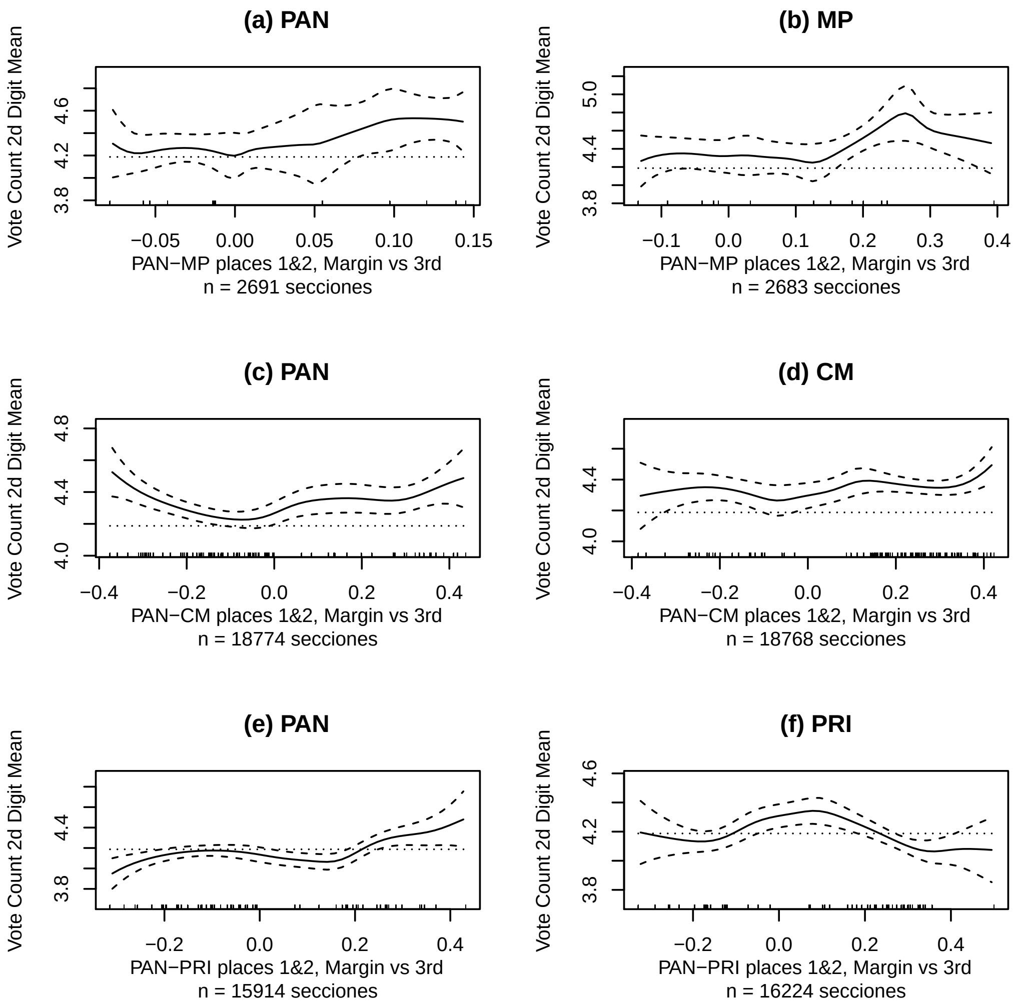
Note: Nonparametric regression of *Mayoría Relativa* vote counts' second digits based on *secciòn* data. Rug plots show locations of *secciòn* values of $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$.

Figure 42: Mexico 2012: *Diputados*, *Sección* Count Second-digit Mean (Districts) by $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$



Note: Nonparametric regression of *Mayoría Relativa* vote counts' second digits based on *secciòn* data. Rug plots show locations of *secciòn* values of $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$.

Figure 43: Mexico 2012: *Diputados*, *Sección* Count Second-digit Mean (Districts) by $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$



Note: Nonparametric regression of *Mayoría Relativa* vote counts' second digits based on *secciòn* data. Rug plots show locations of *secciòn* values of $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$.

Table 21: Municipality Party Affiliations as of the Mexican 2006 Federal Election

Municipality Party Coalition Membership

	PAN	APM	PBT	PAN-PBT	APM-PBT	Other
municipalities	534	782	396	50	56	1,014
secciones	17,721	19,192	10,534	1,666	2,556	13,020

Notes: Each municipality's party affiliation is determined by matching the members of the mayor's coalition to the parties and coalitions presenting candidates in the 2006 federal election. The number of municipalities is the number appearing in the IFE data. The number of *secciones* is the number used for voting in the presidential election.

Table 22: Mexico 2006 Federal Election: *Secciones* with Counts > 9 by Municipality Party

	Party	Municipality Party Coalition Membership					
	Voted	PAN	APM	PBT	PAN-PBT	APM-PBT	Other
Presidente	PAN	17,667	18,341	9,584	1,627	2,459	12,812
	APM	17,620	19,084	10,304	1,663	2,539	12,705
	PBT	17,243	18,570	10,436	1,595	2,412	12,887
	NA	3,740	3,258	2,183	312	582	2,228
	ASDC	10,957	8,173	5,162	680	1,287	9,105
Diputados Federales	PAN	17,662	18,310	9,554	1,623	2,449	12,542
	APM	17,632	19,107	10,331	1,664	2,541	12,682
	PBT	17,012	18,297	10,419	1,565	2,364	12,575
	NA	12,429	11,459	6,626	1,056	1,794	9,869
	ASDC	8,071	5,587	4,643	236	795	7,925

Notes: N of vote counts ≥ 10. Each *casilla extraordinaria* used for presidential voting is treated as a separate *sección*. The values for *Diputados Federales* use only *Mayoría Relativa* vote counts.

Table 23: Mexico 2006 Federal Election: Second Digit Means by Municipality Party

	Party	Municipality Party Coalition Membership					
Presidente	Voted	PAN	APM	PBT	PAN-PBT	APM-PBT	Other
	PAN	4.34*	4.20	4.24	4.18	4.19	4.25
	APM	4.07*	4.13*	3.99*	3.95*	3.93*	4.13
	PBT	4.16	4.20	4.36*	4.24	4.03*	4.33*
	NA	3.28*	3.29*	3.20*	2.90*	3.14*	3.49*
	ASDC	4.18	3.99*	4.19	3.63*	3.97*	4.29*
	Party	Municipality Party Coalition Membership					
Diputados Federales	Voted	PAN	APM	PBT	PAN-PBT	APM-PBT	Other
	PAN	4.33*	4.23	4.17	4.11	4.06	4.23
	APM	4.19	4.22	4.17	4.12	4.15	3.97*
	PBT	4.09*	4.17	4.31*	4.13	4.31	4.25
	NA	4.14	4.07*	4.12	4.17	4.17	4.25
	ASDC	3.82*	3.70*	4.05*	2.89*	3.26*	4.23

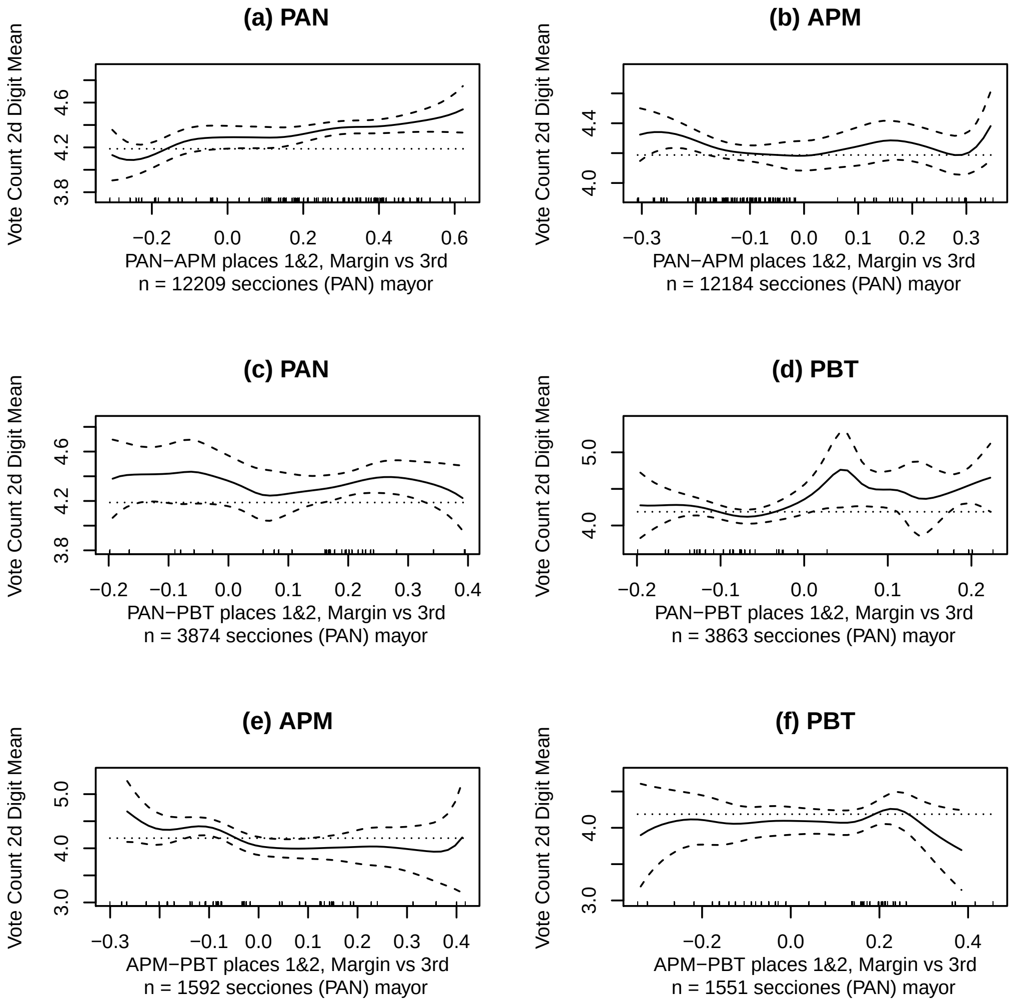
Notes: $\hat{j}$. * shows values that differ by more than two standard errors from $\bar{j}$. Tests are based on *sección* vote counts greater than 9 for the referent party. Each *casilla extraordinaria* used for presidential voting is treated as a separate *sección*. The statistics for *Diputados Federales* use only *Mayoría Relativa* vote counts.

Table 24: Party Affiliations for Municipalities and Districts, Mexican 2006 Federal Election

			Diputados Federales district winner			*Presidente* district winner		
mayor	leading parties	unit type	PAN	PBT	APM	PAN	PBT	APM
PAN	PAN-APM	municipalities	130	—	77	115	—	0
		districts	78	—	20	55	—	0
		secciones	10,046	—	2,191	7,138	—	0
	PAN-PBT	municipalities	39	11	—	86	79	—
		districts	27	6	—	55	37	—
		secciones	3,360	523	—	7,153	2,421	—
	APM-PBT	municipalities	—	41	54	—	21	47
		districts	—	20	25	—	6	23
		secciones	—	586	1,015	—	233	776
PBT	PAN-APM	municipalities	36	—	19	33	—	0
		districts	22	—	7	20	—	0
		secciones	769	—	205	745	—	0
	PAN-PBT	municipalities	38	54	—	38	85	—
		districts	13	24	—	16	47	—
		secciones	871	3,403	—	812	5,319	—
	APM-PBT	municipalities	—	50	104	—	24	102
		districts	—	19	40	—	6	36
		secciones	—	1,090	4,196	—	253	3,405
APM	PAN-APM	municipalities	125	—	82	115	—	0
		districts	54	—	20	44	—	0
		secciones	6,440	—	4,624	5,544	—	0
	PAN-PBT	municipalities	30	33	—	85	81	—
		districts	14	8	—	35	27	—
		secciones	1,350	709	—	5,871	2,775	—
	APM-PBT	municipalities	—	117	112	—	69	131
		districts	—	22	32	—	8	36
		secciones	—	2,733	3,336	—	833	4,169

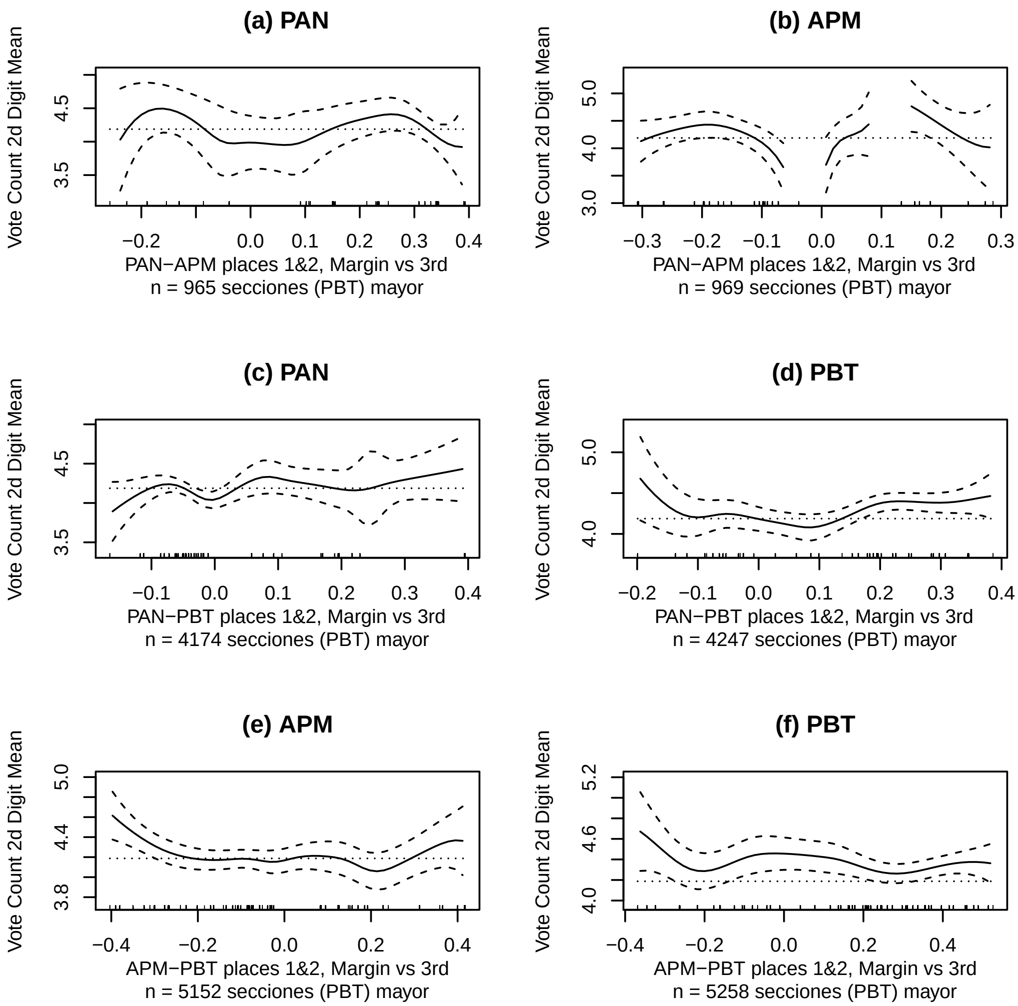
Notes: Each municipality's party affiliation is determined by matching the members of the mayor's coalition to the parties and coalitions presenting candidates in the 2006 federal election. The number of municipalities is the number appearing in the IFE data.

Figure 44: Mexico 2006: *Diputados*, *Sección* Count Second-digit Mean (Districts) by $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$ with PAN Mayor



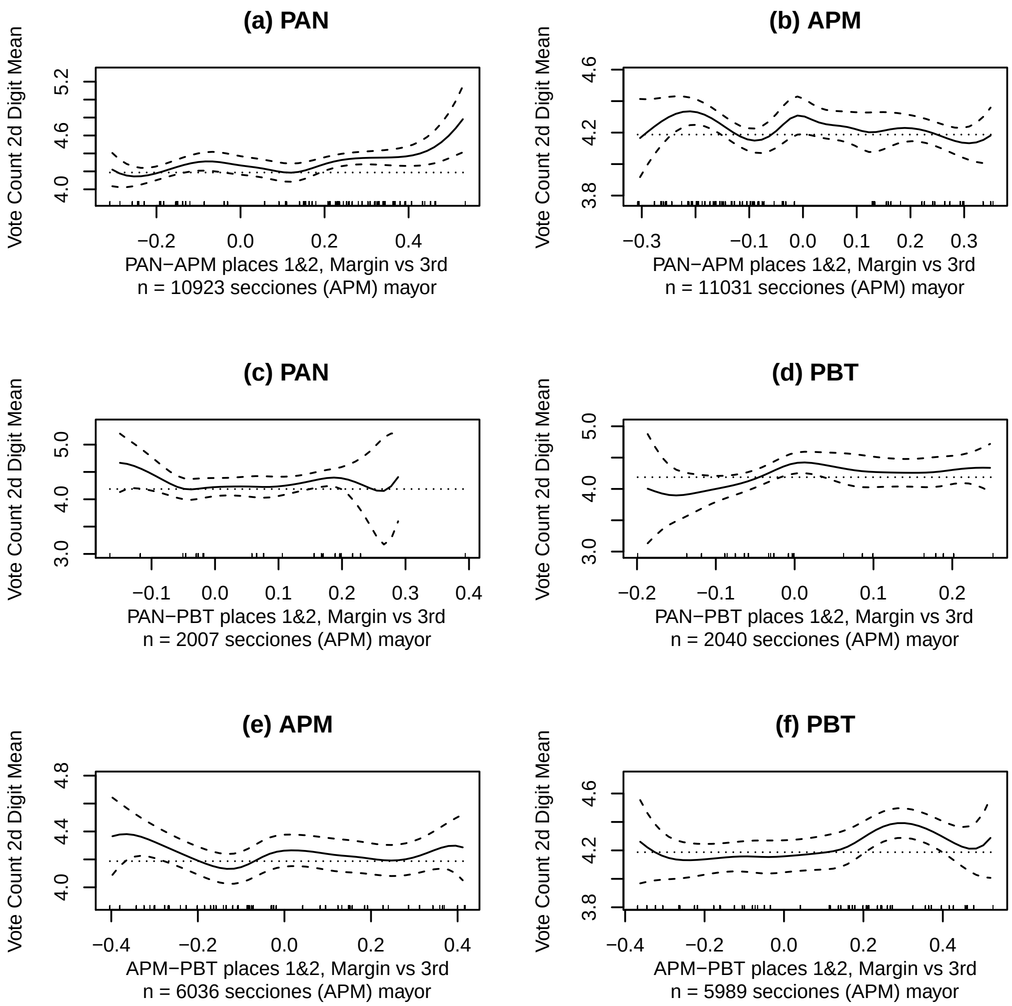
Note: Nonparametric regression of *Mayoría Relativa* vote counts' second digits based on *secciòn* data. Rug plots show locations of *secciòn* values of $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$.

Figure 45: Mexico 2006: *Diputados*, *Sección* Count Second-digit Mean (Districts) by $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$ with PBT Mayor



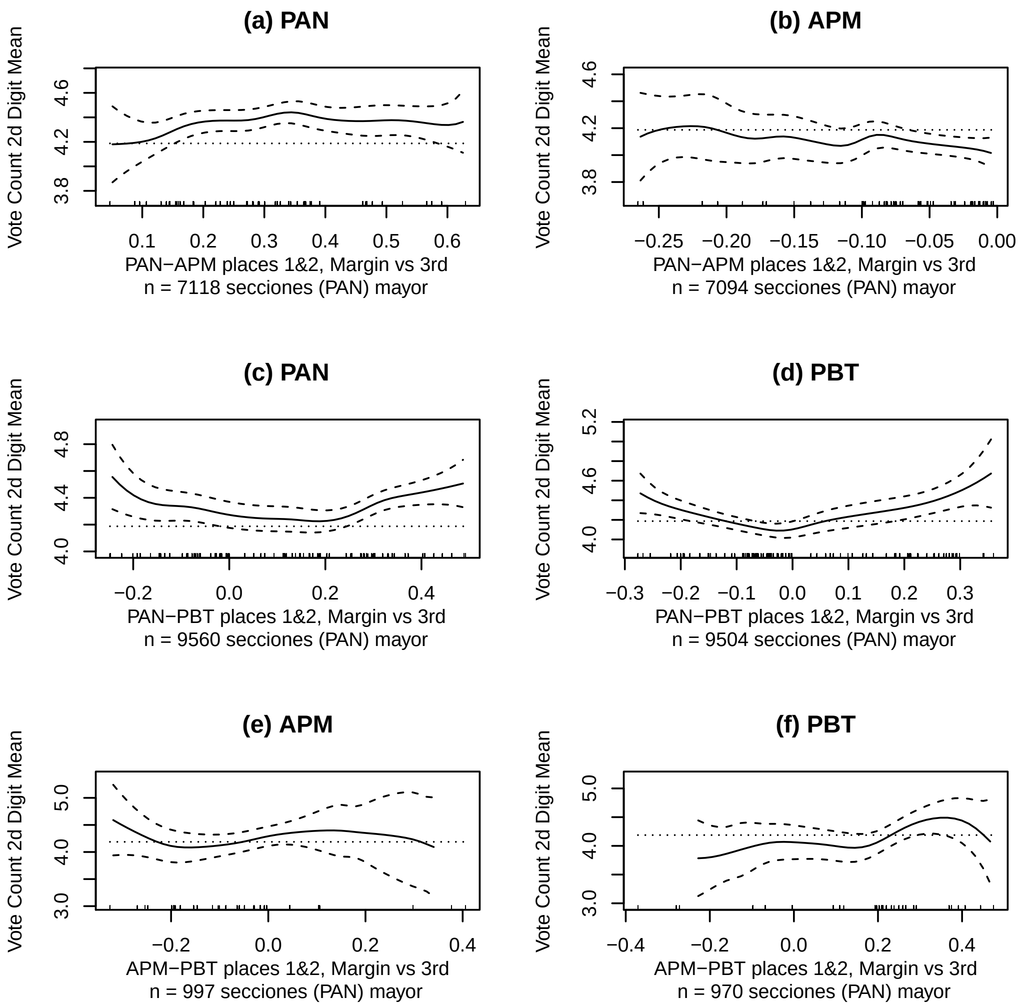
Note: Nonparametric regression of *Mayoría Relativa* vote counts' second digits based on *seccìon* data. Rug plots show locations of *seccìon* values of $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$.

Figure 46: Mexico 2006: *Diputados*, *Sección* Count Second-digit Mean (Districts) by $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$ with APM Mayor



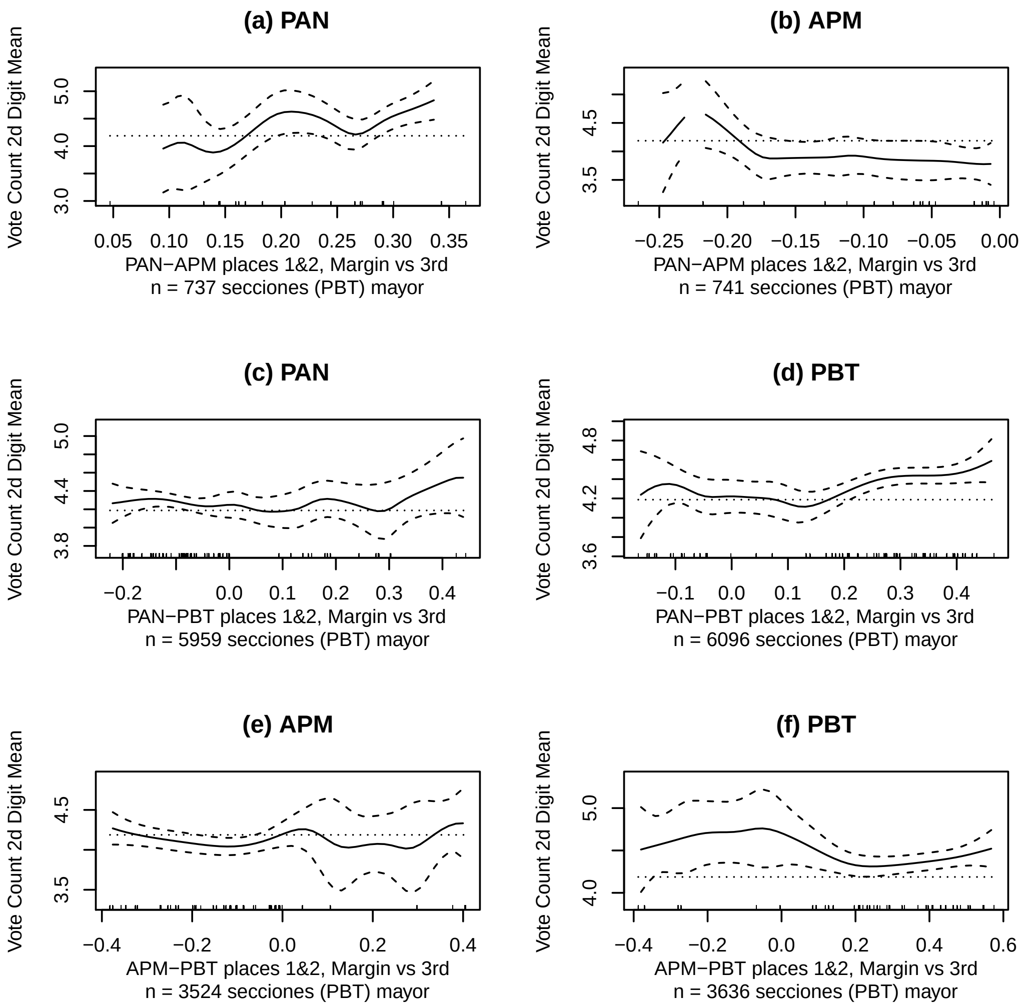
Note: Nonparametric regression of *Mayoría Relativa* vote counts' second digits based on *secciòn* data. Rug plots show locations of *secciòn* values of $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$.

Figure 47: Mexico 2006: *Presidente*, *Sección* Count Second-digit Mean (Districts) by $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$ with PAN Mayor



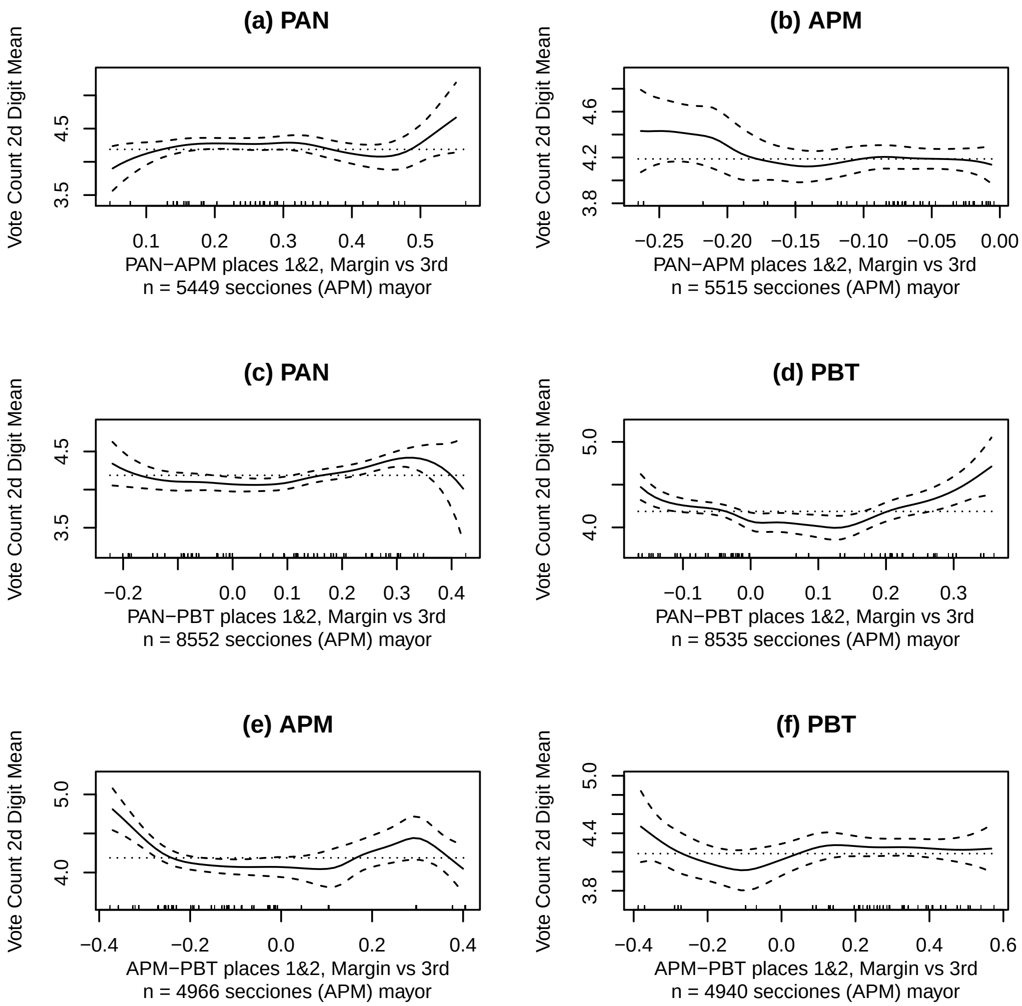
Note: Nonparametric regression of vote counts' second digits based on *secciòn* data. Rug plots show locations of *secciòn* values of $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$.

Figure 48: Mexico 2006: *Presidente*, *Sección* Count Second-digit Mean (Districts) by $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$ with PBT Mayor



Note: Nonparametric regression of vote counts' second digits based on *secciòn* data. Rug plots show locations of *secciòn* values of $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$.

Figure 49: Mexico 2006: *Presidente*, *Sección* Count Second-digit Mean (Districts) by $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$ with APM Mayor



Note: Nonparametric regression of vote counts' second digits based on *secciòn* data. Rug plots show locations of *secciòn* values of $-\mathfrak{M}_{23}$ and $\mathfrak{M}_{13}$.