# Changing Votes or Changing Voters? How Candidates and Election Context Swing Voters and Mobilize the Base*

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**Abstract**

To win elections, candidates attempt to mobilize supporters and persuade swing voters. With what magnitude each operates across American elections is not clear. I argue that the influence of swing voters should depend upon change in the candidates across elections and that the consequences of changes in composition should depend upon the relative balance of campaign expenditures. I estimate a Bayesian hierarchical model on Florida electoral data for house, governor, and senate contests. Swing voters contribute on average 4.1 percentage points to change in party vote shares, while change in turnout influences outcomes by 8.6 points. The effect of swing voters is increasing in the divergence between the Democrat and Republican candidates. Candidates increasingly benefit from the votes of occasional voters as the relative balance of campaign spending increases in their favor. More broadly, the effects of swing voters and turnout are not constant features of American elections, instead varying across time and space in ways related to candidates and context.

**Keywords:** Electoral change; Swing voters; Campaign mobilization; Hierarchical model.

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In American elections, campaigns aim to increase their chances of victory by mobilizing supporters to turn out and by persuading swing voters to their side. Candidates and parties spend billions of dollars on campaign activities toward these goals, and victorious parties assert mandates to implement the policies they advocated during their campaign. How parties gain or lose votes across elections has important implications not only for the direction of policy change after the election, but for our understanding of how voters make choices and hold politicians accountable to their interests and how campaigns allocate scarce resources. More broadly, if congressional elections are increasingly nationalized and the candidates polarized, it may be that persuasion becomes a less viable strategy relative to mobilization. Do parties and candidates win more often by persuading swing voters, or by better mobilizing their supporters?

Despite the importance of these questions, we lack basic empirical and theoretical understanding of when swing voters or mobilization are of larger or lesser influence on partisan outcomes. While scholars at least as far back as Key (1966) have investigated the question, determining the relative contribution of swing voters and changes in turnout to aggregate electoral change is not trivial. Because of the secret ballot, it is difficult to observe the actual voting behavior of individual voters in even one election, let alone across elections. While opinion surveys offer the opportunity to ask citizens whether and for whom they voted in one or more elections, sample sizes are small, memories are fallible, and various biases plague opinion survey reports of turnout and vote choice. Thus, the individual behavioral processes underlying change in party vote shares across elections in the United States is not well understood.

In this article, I explore the likely sources of electoral change using standard political science models of voting. Electoral change may follow from many citizens participating in both elections and changing their votes from one party to the other (what I call *switchers* following Key, 1966). But electoral change may also occur due to changes in the sizes and vote choices of the set of eligible citizens who participate in only one of the two elections (what I call *change in composition*). Applying political science models to contests across two elections suggests that swing voters should be increasingly important in contest pairs where the two sets of candidates are less similar.

With respect to change in composition, standard models suggest change in the relative campaign resources expended should influence the effects of change in composition on party vote shares.

To explore these theoretical implications and measure the relative effects of switchers and changes in composition, I estimate a Bayesian hierarchical model on novel data to estimate the contribution of these two factors to electoral change. I implement this method in the state of Florida from 2006 to 2010 for gubernatorial, presidential, U.S. Senate, and U.S. House contests. I merge individual records of turnout from statewide voter files to precinct-level election returns to estimate the contributions of both switching and composition to electoral change. I use a hierarchical model to estimate in each precinct the number of switching voters and the number of voters for each party who participate in only one election or the other. The turnout data from the voter file serve as predictors for these counts. The method respects the observed vote counts in every precinct in each election, allowing me to aggregate across precincts to the level of the contest and describe electoral change in whole.

I find that voters who participated in both elections switched between the parties for an average net effect of about 4.1 percentage points across the contests I analyze. I estimate an average net effect of change in composition of 8.6 percentage points, though the effect is notably higher in contest comparisons between 2008 and 2010 than between 2006 and 2010. Both effect sizes vary across contests, and I show that the effect of switching voters increases with the dissimilarity of candidates in the two elections. I also find that change in the balance of Republican campaign spending across contests predicts the size of the advantage for the Republican candidates from change in the composition of the electorate. Finally, my results confirm that the old adage that "increased turnout benefits the Democrats" is not safe to assume.

This article makes three contributions to the study of elections, electoral change, and turnout. First, I apply standard models of voting behavior across two elections to understand electoral change. I find that three traditional schools of political science, the Michigan, Columbia, and Rochester schools, all suggest similar predictions for when we should see more or less switching between the parties. I also apply the three models plus more recent findings on the effects of get-out-the-vote activities to develop hypotheses about when changes in composition should benefit each party across two elections. Second, I present a framework and hierarchical statistical model to estimate directly the factors of electoral change using election-wide administrative data not subject to survey biases or small samples. Third, I test the theoretical implications empirically, showing that there are no universal effects of turnout or switching voters. Rather, these effects are contingent on candidate and campaign context in predictable ways.

The essay proceeds first by presenting previous work on switching voters and the partisan consequences of changes in composition, then exploring theoretical implications for electoral change across two elections through individual level behavioral choices. I continue by describing a Bayesian hierarchical model to estimate the quantities of the behavioral choices from aggregated precinct-level data, and estimate that model on Florida election data. I present contest-level results and their relationship to candidates and context, and offer concluding remarks.

## Estimates of the factors of electoral change

A great variety of scholarship has separately considered the phenomena of swing (or switching) voters and the partisan implications of turnout. Less research has considered the two factors of electoral change together in a unified framework. The limited attention to the combined and relative effects of switchers and change in composition of the electorate is likely due to difficulties in data. These limitations have not changed dramatically in the half century since V.O. Key wrote,

> Election statistics can tell us nothing about the movements of voters to and fro across party lines; they give only a net measure of changes in the party division from election to election. To trace changes or identify continuities in voter sentiment over time one must employ some variant of the survey sample (Key, 1966, p. 11).

The survey sample has been used widely. For example, Campbell (1960) shows that peripheral voters surge in support of a favored candidate in one election but do not show up at the next, leaving only the core voters participating at the second election and changing the party vote. Shively (1992) uses panel surveys to validate his aggregate analysis, presenting net effects of switching voters of

7.7 and 10.7 percent of vote share, and net effects of “differential abstention” of -0.3 and 3.0 percent, 1956 to 1960 and 1972 to 1976. Lupia (2010) uses self-reported recall of 2004 vote in the 2008 ANES to show that one quarter of those who voted for Republican George W. Bush in the 2004 presidential election failed to vote for the Republican John McCain in 2008, either because they stayed home (7 percent), voted for the Democrat Barack Obama (15 percent), or voted for another candidate (1 percent). These efforts with survey data indicate that swing voters are a larger contributor to electoral change than changes in composition.

Despite Key’s admonition about electoral data, and perhaps because he shows only pages later the problems of over-reported vote for the winning candidate in the previous election (Key, 1966, Table 2.1, p. 14), scholars have turned to aggregate electoral data to understand the nature of electoral change. DeNardo (1980) shows with a sample of congressional district elections from seven states and six elections that increasing turnout favors the majority party, but with variation by the level of turnout and across time. Shively (1982) uses nationwide presidential vote totals to show that the partisan margin from stable voters was a much larger contributor to election results than the partisan shifts of unstable voters from 1888 to 1980. Shively (1992) shows that conversion has become increasingly relevant in presidential, congressional, and state legislative elections since the 1960s. Ansolabehere and Stewart, III (2010) use precinct-level observations from Massachusetts to draw inferences about change from presidential vote in 2008 to a special election in 2010.

Theory and evidence on when switching and composition should be of larger or smaller effect is underdeveloped. Even a basic definition of *swing voters* is unsettled, with most research measuring switching behavior based on responses to a single cross-sectional survey. Swing voters have been alternatively identified by cross-pressured group memberships (Berelson, Lazarsfeld, and McPhee, 1954), self-reported independent partisan identification (Campbell et al., 1960), self-reported recall of different party presidential vote (Key, 1966; Lupia, 2010), self-reported ticket-splitting (De Vries and Tarrance, 1972), balance in affective evaluation of the two competing candidates (Kelley, 1983; Mayer, 2007), conflicts between voter issue preferences and the issue positions of the parties or candidates (Campbell et al., 1960; Hillygus and Shields, 2008), indifference between the parties' economic policy platforms (e.g. Krasa and Polborn, 2014; Persson and Tabellini, 2000), or by traits relevant to a psychological model of persuasion such as information and media exposure (Converse, 1962; Zaller, 2004). Because of different definitions of swing and a lack of cross-time measurements, consensus on who the swing/switching voters are or how much influence they have on changing partisan electoral fortunes is limited.

Measuring the effects of change in composition on electoral change has also proceeded with a variety of measurement perspectives and different empirical results. Scholars have produced mixed results that even large differences in composition have substantial partisan electoral consequences despite the dramatic variation in participation at the individual level. Formal and empirical studies of *surge and decline* – the phenomenon that presidential elections engage millions more citizens than midterm elections (Campbell, 1960; Burnham, 1965) – sometimes identify partisan consequences of changing turnout (Campbell, 1960, 1987) and other times do not (DeNardo, 1980; Wolfinger, Rosenstone, and McIntosh, 1981). Likewise, simulations and estimates of full turnout elections often fail to find significant partisan consequences (Erikson, 1995; Highton and Wolfinger, 2001; Citrin, Schickler, and Sides, 2003; Hill, 2014), while others suggest that turnout may have had consequences prior to about 1965 but not after (Shively, 1992; Nagel and McNulty, 1996; Martinez and Gill, 2005).[1] Despite individual characteristics such as income that correlate both with the decision to come to the polls and with party preference, and the regularity with which the president's party loses seats at the midterm at the same time as a large decline in turnout, it is not clear how or when changes in composition affect which party wins elections.

### Factors influencing the magnitude and direction of switching and turnout

Stepping back from the varied empirical evidence, I present in this section a theoretical exploration of when we might observe greater and lesser effects of switching voters and changes in composition on electoral change. I apply three of the standard models of voter behavior from American

[1] See Hajnal and Trounstine (2005) and Anzia (2012) for potentially consequential effects of turnout in lower-stimulus local elections.

political science, the Columbia, Michigan, and Rochester schools, to this question. The three models suggest that similar factors should be related to the two components of electoral change.

The first influence on change in party vote shares is the effect of voters who switch their votes from one party to the other across two elections. When should more or fewer voters switch votes between the parties? I follow Key (1966) in limiting the definition of switchers to those voters who participate in both elections. There are three types of voters in the simple case of two parties, $A$ and $B$, contesting the two elections. Voter types one and two either twice vote for the candidate of party $A$ or twice vote for the candidate of party $B$, what Key calls *standpatters*. Type three are Key's *switchers*, those voters who vote once for party $A$ and once for party $B$.

With respect to switchers, the Columbia sociological model of vote choice (e.g. Berelson, Lazarsfeld, and McPhee, 1954) suggests that cross-pressured group memberships lead to voters who might switch between the parties. When two groups to which a member belongs support different candidates, the individual faces a conflict about whom to support. The Michigan psychological model of vote choice (e.g. Campbell et al., 1960), on the other hand, suggests that voters will generally support the candidate from the party to which they hold a long term attachment. However, occasionally short-term factors such as candidate characteristics may sway the voter away from their usual choice. Thirdly, the Rochester rational choice model of vote choice (the spatial theory of voting, e.g. Downs, 1957; Enelow and Hinich, 1984) suggests that voters will switch between the parties when their ideal policies are more spatially proximate to the candidate from party $A$ in one election and more proximate to the candidate from party $B$ in the second election. Key's switchers, then, are those voters for whom the closer candidate at the first election is from a different party than the closer candidate at the second election.

All three models suggest that short term switching between the parties is a function of changes in the characteristics of the candidates or context of the two parties at the two elections. There should be fewer switching voters the more similar the two sets of candidates contesting the two elections. In contrast, there should be more switching voters the more distinct the two sets of candidates contesting the two elections. One way to operationalize the *distinctness* of two contests is to summarize the characteristics of the candidates to some numeric summary value, and divide the electorate at the midpoint between numeric values of the two candidates – i.e. the usual Downsian spatial model of voting, but applied here across two contests.[2] Below, I relate change in the location of the midpoint between the candidates in each of two elections to estimates of the number of switching voters.

**The effect of change in composition**

With respect to switching, I limited attention to those citizens who turn out in both elections. The second influence on change in party vote shares is the relative size and candidate preference of the voters who participate in only one election or the other – the effect of change in composition. When should change in composition have larger and smaller effects?

The Columbia school suggests that party effort mobilizes marginal voters (e.g. Berelson, Lazarsfeld, and McPhee, 1954, p. 171–175), while the Michigan school suggests that the choice to participate is a function of engagement with the political process and the salience of the election. Turnout in the Rochester school is based on the differential utility from the candidates and the likelihood that the voter's participation is pivotal. More recent research on turnout confirms the importance of party contact from the Columbia perspective (e.g. Gerber and Green, 2000).

In all of these models, participation should increase as interest, salience, stakes, and party effort for voter contact increase. With respect to the partisan consequence of change in composition, relative balance in campaign effort should influence the partisan magnitude and direction of the effect on vote share. Campaigns attempt to mobilize those citizens that they expect support their candidate. Through this targeted activity, mobilization can change the set of voters who come to the polls (e.g. Berelson, Lazarsfeld, and McPhee, 1954; Green and Gerber, 2008; Holbrook and McClurg, 2005). When one campaign has a resource advantage over the other, they differentially

[2] Of course, this numeric dimension could also summarize relative group memberships or relative balance of short-term forces from the perspective of the Columbia or Michigan schools. Other sources of switching votes in this context are a change in voter preferences across elections, such that even if the midpoint between the candidates is at the same location in both elections, voters with different preferences may switch their votes between the parties. A change in the relative valence advantages of the candidates might also be relevant (e.g. Atkinson, Enos, and Hill, 2009; Groseclose, 2001).

affect the costs and benefits for electors that are more likely to support their candidate. Applying this logic across elections suggests that change in the balance of campaign spending between the candidates of parties $A$ and $B$ across elections should directionally predict the partisan consequence of changes in composition across elections. As party $A$ gains a relative advantage over party $B$ at the second election compared to the first, they should benefit more from the voters who turn out in the second election but not in the first – or lose less from the voters who participate in the first election but not in the second. The converse also holds for a relative advantage for party $B$.

A related literature in political science has argued about whether or not increases in turnout universally benefit Democrats due to the nature of their coalition (e.g. Citrin, Schickler, and Sides, 2003; DeNardo, 1980, 1986; Nagel and McNulty, 1996). My discussion here highlights that an important unstated component in this question is "benefits Democrats relative to what?" The exploration here highlights that the influence of changes in turnout is contingent on changes in the context in the election. If mobilization stimulus, either through campaign effort or change in the salience of the elections, moves from benefiting the Democrats in the first election to benefitting Republicans in the second, turnout may increase to the benefit of Republican candidates.[3] This suggestion is consistent with empirical evidence below.

In summary, exploration of traditional models of voting and turnout from political science to two consecutive elections suggests empirical implications for when switching voters and change in composition might be of greater and lesser influence on change in vote share. The magnitude of the effect of switching voters should increase as the distinctness of the competing candidates become less similar from election one to election two. More specifically, party $A$ should increasingly benefit as the midpoint between the two party candidates moves toward party $B$ at the second election, and party $B$ should increasingly benefit as the midpoint between the two party candidates moves toward party $A$ at the second election. Meanwhile, the magnitude of the partisan effect of change in composition should increase with change in the relative balance of campaign activity

[3] See also Hill (2014) for evidence of election-specific turnout valence advantages that do not universally benefit Democrats.

Table 1: Cross-tabulation of individual behaviors relevant to electoral change

| | **Rep**$_1$ | **Oth**$_1$ | **NoVote**$_1$ |
|---|---|---|---|
| **Rep**$_2$ | $n_1$ | $n_2$ | $n_3$ |
| **Oth**$_2$ | $n_4$ | $n_5$ | $n_6$ |
| **NoVote**$_2$ | $n_7$ | $n_8$ | $n_9$ |

*Note: Each cell in the table represents a count of citizens who made that combination of behaviors at election one (column) and election two (row).*

across the two elections. Party $A$ should increasingly benefit as the spending differential benefits party $A$ more at election two than election one. I turn next to measuring these relationships.

## Characterizing electoral change through individual behaviors

The data used to observe electoral change by researches to this point has not always been sufficiently powerful to exploit variation in campaign and candidate context across contests and therefore to understand the relationships to the effects of switching voters and change in composition. In this section, I present a framework for describing electoral change that can use more extensive electoral data across multiple contests.

Electoral change at the level of the contest, say from one presidential election to the next, is simply the aggregation of a set of individual citizen choices in each of two elections. First, each citizen chooses either to turn out or to stay home (or is somehow ineligible or incapacitated). Second, each citizen who chooses to turn out chooses for which candidate to cast a vote. The aggregation of these choices up to the contest determines each party's vote share in each election, and consequently the winner in each election. In Table 1, I present a cross-tabulation of the individual behaviors relevant to electoral change across two elections (this accounting is similar to those presented in Shively, 1982, 1992). Each column presents a behavior at the first of two elections and each row a behavior at the second election. For example, Rep$_1$ indicates voting for the Republican at the first election and NoVote$_2$ represents not voting at the second election. For simplicity, I collapse all non-Republican candidates into vote behaviors Oth$_1$ and Oth$_2$.

The cells of Table 1 represent the counts of citizens engaging in each combination of behaviors from the two elections. For example, $n_4$ represents the count of switchers who changed their votes from the Republican at election one to a non-Republican at election two, and $n_6$ is the count of voters who do not vote at election one but vote for a non-Republican at election two.

The set of cell counts $n_1$ to $n_9$ fully describes the nature of change in party vote shares across the two elections. The net change in Republican vote counts due to switching voters, for example, is $n_2 - n_4$, the number who switch to the Republican ($n_2$) minus the number who switch away from the Republican ($n_4$). The theoretical exploration above suggests, for example, that this difference should be increasing as the policies offered by the Republican and non-Republican candidates become more distinct across elections, all else equal.

Describing the effect of change in composition is slightly more complicated because it depends upon the relative sizes of the electorate at election one ($n_1 + n_2 + n_4 + n_5 + n_7 + n_8$) and election two ($n_1 + n_2 + n_3 + n_4 + n_5 + n_6$). In Appendix Section A, I describe how I compare these quantities when turnout differs across the two elections, which complicates comparison by changing the denominator of the calculation of Republican vote share. Observe that the Republican candidate at election two benefits as $n_3$ increases and as $n_6$ decreases, and that the relative change from election one is also a function of the counts $n_7$ and $n_8$. The net benefit for the Republican from change in composition is equal to $(n_1 + n_3 + n_4)/(n_1 + n_2 + n_3 + n_4 + n_5 + n_6) - (n_1 + n_4 + n_7)/(n_1 + n_2 + n_4 + n_5 + n_7 + n_8)$. The theoretical exploration above suggests, for example, that this quantity should increase as the Republican effort and resource advantage over opponents increases relative to election one, all else equal.

**Statistical model of individual behaviors of electoral change**

Due to the secret ballot, we do not observe the interior counts of Table 1 for full elections. My empirical goal, then, is to estimate the counts of electoral change in Table 1 for full electorates across multiple contests. I use administrative election data for the full electorate, rather than the smaller observation from a survey sample. Importantly, I use precinct election returns, which provide more specific counts across elections than election-wide totals. Some precincts have much more information about the interior cell counts than others, and almost always more information than larger aggregates such as counties or full contests. Estimating these counts across multiple contests allows me to exploit variation in the types of candidates contesting each election, in campaign effort, and in the estimated relationship of each to electoral change.

To estimate $n_1$ to $n_9$ for each pair of elections, I use a hierarchical Bayesian model. I present the full model in Appendix Section B, which is an extension of the ecological inference model presented by Wakefield (2004), and present here the basic intuition. The model takes as observations the full set of precincts within a specific contest pair. For example, consider all precincts that voted for the 15th U.S. House district in Florida in 2006 and 2010. Voters in each of these precincts cast some number of votes for the Republican candidate in 2006 and some number for the Republican candidate in 2010.[4] Likewise, voters in each precinct cast some number of votes for other candidates, and a final set of citizens did not vote in each election. These observed counts represent the marginal totals in Table 1 and serve as the central observed data for the model.

While we do not observe the interior counts in each precinct, $n_1$ to $n_9$, the marginal totals provide constraints on the values each cell might take. This is the familiar statistical problem of ecological inference. For example, $n_1+n_2+n_3$ equals the total votes received by the Republican at election two, $n_2+n_5+n_8$ equals the total votes received by non-Republican candidates at election one, and so forth. The model estimates the interior counts so that they are always consistent with the observed marginal totals.

Each cell count $n_j$ in every precinct is bounded by the adding up constraints of the observed marginal totals, but as is well known with problems of ecological inference, these bounds are often too wide to provide much precision. To provide more specific estimates of the factors of electoral change, the model pools observations across precincts in a hierarchical fashion, as has been suggested and implemented by others (e.g., Imai, Lu, and Strauss, 2007; King, 1997; Lewis, 2004). I allow characteristics of each precinct to be predictors for the cell counts $n_1$ to $n_9$. For example, I use as predictors data from the statewide voter files, which record the turnout choices of each registrant in each precinct. If the proportion of registrants who are registered Republican

[4] Precinct boundaries may change across elections. I aggregate changed precincts together to create common precincts across election pairs composed of the same set of registrant addresses. See Appendix Section D for details.

and turn out in both elections is correlated positively with bounds on the number turning out twice and voting for the Republican in both elections ($n_1$) as seems likely, then the model coefficients can map this proportion across precincts into the estimate of $n_1$ in each precinct. Of course, the model may also estimate coefficients of zero if these predictors are not informative to the values of the cell counts.

Three features of the predictor variables are important to note. First, the adding up constraints are always respected, no matter what values the predictor variables take. Second, the model can estimate coefficients near zero if the predictors do not provide explanatory power for the cells. And, third, I allow the coefficients to vary across precincts as random effects to accommodate measurement error.

This model is relatively straightforward, but its success in estimating the internal cell counts depends on features of the data. First, the bounds provided by the vote and abstention totals from each election vary in the informativeness about interior cells. In general, bounds are more narrow when the vote splits in the two elections are closer to landslide, or when the marginal totals are small. Some precincts in the data are small and some are landslide, but others are large with more modest vote splits. For these latter types of precincts, the model estimates depend upon the pooling across precincts and the validity of the predictor variables. That is, the model will estimate where within the bounds the actual count is likely to lie based upon the cross-precinct pooling of the relationship between counts and predictors. The model will be more successful when these relationships are relatively homogenous across precincts, and will have more uncertainty when the relationships are more heterogeneous. For example, I use voter file data to predict the internal cell counts. The model will be more effective when the voter file data is of high quality and when the characteristics of registrants are good predictors of their voting behavior in the elections under study.

In Appendix Section C, I provide simulation evidence confirming these statistical properties. I also show for precincts of similar size and margins to those in the data, credible interval coverage from simulations is reasonable. I also note here that the set of predictor variables I include is not exhaustive. In fact, a feature of the model is that other predictors could be brought to bear, such as demographic or other features of precincts and contests.

This model estimates the cell counts and their variation in each precinct in each contest pair. As an example, I present in Appendix Table A3 my estimates for precinct 1132 in the Florida 15th district from 2006 to 2010. My median posterior estimates suggest, for example, that about one hundred voters participated in both elections and switched from a non-Republican to a Republican from 2006 to 2010, while only a handful switched from a Republican to a non-Republican (cells $n_2$ and $n_4$, respectively).

## Data and estimation of electoral transitions

In the previous section, I presented the statistical model to estimate the counts of individual electoral behaviors in each precinct in each contest. In this section, I present the data used to estimate the model and examine the relationships between candidates, election context, and the effects of switching voters and change in composition.

I use electoral data from the state of Florida. Florida is a large and diverse state with competitive elections during this time period. I collected precinct election returns for 2006, 2008, and 2010 from the state redistricting commission's web page. The data compilation includes precinct election totals for 11 U.S. House races, one U.S. Senate contest, and one gubernatorial contest in 2006, the presidential contest only in 2008, and 23 U.S. House races, the U.S. Senate contest, and the gubernatorial contest in 2010.[5] These data lead to two different types of contest pairs. For 2006 to 2010, I calculate electoral change for votes in the same contests, e.g. house to house, senate to senate, and governor to governor. For 2008 to 2010, because I only have presidential precinct returns from 2008, I calculate electoral change from presidential vote in 2008 to house, senate, or governor vote in 2010. Although this is in some ways a limitation, it also explores different types of electoral change of broad interest: change within the same contest, and change from a presidential election to a midterm election.

[5] See Appendix Section D for details of data compilation and a summary of the contests with numbers of precincts and vote share in Appendix Table A2.

Compilation of these data was not trivial. Because precinct boundaries change across elections, I have aggregated precincts from each election to common precincts that contain the same set of residential addresses in each election. In Appendix Section D I detail this procedure, which aggregated around 7,000 election precincts to around 6,500 common precincts. Further, I use the statewide voter files to describe the behavior of more than 14 million Florida registrants across multiple elections. Because precinct boundaries may change across elections and because registrants move across time, I created common precincts that encompass the same set of residential addresses in each of the two elections with separate voter files produced shortly after each election (2006, 2008, and 2010).[6] I compiled who voted in one, both, or neither of the elections for each pair of contests, and then merged those characteristics to each precinct.

There was notable electoral change in Florida between 2006 and 2010. Democratic House candidates received 42 percent of votes in 2006 compared to 38 percent in 2010, and Democratic presidential candidate Barack Obama received 50.6 percent of the statewide vote in 2008. Four House seats (2, 8, 22, and 24) changed hands in 2010. To show the distribution of the electoral change and explore the relationship to changes in turnout, I present in Figure 1 change in vote share for the Republican candidate versus change in turnout. The graph is partitioned by 2006 to 2010 election pairs and the 2008 to 2010 election pairs, where the presidential turnout is much higher than in the two midterm elections. The left frame shows that the larger the increase in turnout from 2006 to 2010, the better the Democratic candidate did in the geography relative to the Democratic candidate in 2006. The second frame shows the opposite partisan pattern, where the less turnout fell in 2010 relative to 2008 (the higher the turnout in 2010), the better the 2010 Republican candidate did relative to performance in 2008. These figures also show clear heterogeneity across contests relative to the linear trends. This exploration highlights that changes in total turnout does not have clear and consistent partisan consequences, even in consecutive elections in a single state.

*** Figure 1 here ***

My model brings information from the state voter files to help clarify the relationship of turnout

[6] For full details, please see Appendix Section D.

and help estimate the consequences of switching voters. To show the value of voter file data and the theoretical suggestion of exploring change in context, I plot in Figure 2 change in GOP vote share on change in the proportion of the voting electorate registered Republican by district.[7] The slope suggests a positive relationship between change in the partisan composition of the electorate, measured by party of registration of those registrants who turn out, and change in partisan vote share. Compared to Figure 1, the pattern in Figure 2 is less variable and is consistent across the two election pairs.

*** Figure 2 here ***

The comparison in Figure 2 does not indicate how much of the change in vote share in each contest comes from switching voters versus from changes in composition. Although there is a positive relationship between change in vote share and change in composition of voter partisanship, it is both noisy and potentially correlated with the number of switching voters. To gain a more accurate estimate, I implement the hierarchical model described above for each precinct within each contest.[8] In each precinct, I merge to the election returns characteristics of the registrants in that precinct: I tabulate the party of registration of voters who turned out only at election one, who turned out only at election two, and who turned out in both elections. These characteristics from the voter file serve as predictors for the counts of each combination of behaviors across elections in the statistical model.

## The effects of switching and composition

In this section, I present my estimates of the effects of switching voters and change in composition on electoral change in the Florida elections. I show that the average effects are significant, but that the effect varies notably across contests. I then show that variation in the effect across contests is partially explained by the characteristics of the candidates and the expenditures in the contest.

In Figure 3, I present estimates of the net effects of switching voters and of change in compo-

[7] Note that Florida's 8th, 12th, and 25th district had Tea Party candidates in addition to Republican candidates in the 2010 general elections. They received vote shares of 3.8, 10.7, and 3.0 percent, respectively. See `http://election.dos.state.fl.us/elections/resultsarchive/Index.asp?ElectionDate=11/2/2010`, retrieved January, 2014. I code these votes as GOP votes in the model.

[8] I implement the model in `JAGS` (Plummer, 2013*a*,*b*) and present estimation details in Appendix Section F.

sition in each election and contest pair. I take my estimates of the cell transition counts from each precinct, and aggregate up to each contest to describe electoral change. All point estimates are posterior median values of these sums. The effect of switching voters is the net effect on Republican vote share at election two of voters who switch between the parties, and the effect of composition is the net effect on Republican vote share from voters who turn out in only one election or the other.[9] Note that in each contest the net effect of switching voters and the net effect of change in composition always sum to the total change in vote share for the Republican.[10]

*** Figure 3 here ***

The net effect of switching voters averages 4.1 percentage points in this set of contests. This average, however, masks important variation, with the effects ranging from close to 0 to near 14 points. The net effect of change in composition averages 8.6 percentage points in these contests. The effect is notably larger in the 2008 to 2010 contest comparisons (indicated by the square rather than circle points). This is likely due to Florida having been an important swing state in the 2008 election with large amounts of campaign resources expended on mobilization activities. These presidential expenditures were withdrawn at the 2010 midterm. As with the effect of switching, the average effect masks important variation across contests, with the effects ranging from near 0 to 23 points.

The distribution of these estimates suggests two important features about electoral change. First, the average absolute effect of change in composition is more than twice as large as the average absolute effect of switching in these election pairs. Turnout appears to be a highly relevant factor in electoral change. Second, there is wide variation in both influences across contests. In many contests, the net effect of switching voters is essentially zero. While large effects of switching voters on vote share near 15 points do occur, these are less common. Similarly, there is wide variation in the effect of turnout. I turn next to explore variation in these effects across candidates

[9] I present the calculation of each quantity as a function of my estimates of the cell counts $\boldsymbol{n}_j$ in Appendix Section A.

[10] In this figure, I present the absolute value so that the few contests where the Democrat benefitted are still plotted as positive values to allow consideration of the overall distribution of effects. Below, I analyze the non-absolute values in relation to candidates and spending.

and campaign context.

**Relationship to candidate ideology and campaign spending**

Political science theories of voting applied across two elections suggest that the magnitude and direction of the effect of switching voters should vary with change in the distinctness of the set of candidates contesting each election pair. To characterize this distinctness, I consider change in candidate ideology. While ideology is most closely related to the Rochester model of voter behavior, it is also correlated with partisanship and, in many cases, group membership.

To calculate the midpoint residing halfway between the policy locations of the Democrat and Republican candidates in each contest, I use estimates derived from campaign contributions by Bonica (2013*a*,*b*). The method places candidates on an ideological dimension based on the set of contributions they receive and the assumption that donors send their contributions to candidates in ways that reveal the candidates' ideology. The Bonica (2013*a*) data locate each Florida candidate on a common scale that may represent a dimension of political conflict salient to voters. I calculate the midpoint between the two candidates in each election, then the distance between the two midpoints in each election, first to second. As this difference becomes more negative, the midpoint has moved farther left from the first to the second contest and more voters should prefer the right candidate at the second election, all else equal. Likewise, as this difference becomes more positive, the midpoint has moved farther right between the two contests and more voters should prefer the left candidate at the second election, all else equal.

For example, in the U.S. Senate contest, the midpoint in 2006 was 0.22, halfway between the Democratic candidate score of -0.68 and the Republican candidate score of 1.12. The midpoint in 2010 was 0.17, halfway between the candidate scores of -0.81 and 1.16.[11] The difference in these two midpoints of -0.05 is my measure of the change in distinctness for the Senate contest from 2006 to 2010. This is not a large change in the contest midpoint compared to many of the contest pairs in the data.[12]

[11] I use dynamic CF score estimates (Bonica, 2013*a*). Note that by averaging and taking the difference across contests, I may be lessening problems of measurement error in the estimates of each of the individual candidates.

[12] For all comparisons that look at electoral change from 2008 to 2010, the midpoint at election one is -0.23, halfway

I plot in Figure 4 the net effect of switching voters and the net effect of change in composition against the change in the location of the contest midpoint. I expect a negative relationship between the change in the contest midpoint and the effect of switching on GOP vote share, and am agnostic about a relationship with change in composition. I find a negative relationship with the effect of switching, noted by the best linear fit line, and also discover a negative relationship with the effect of composition, though the data points are spread more noisily with respect to composition. This figure suggests voters are responsive to changes in the distinctness of candidates across elections, especially those electors who participate in both elections.

*** Figure 4 here ***

I turn now to evaluate the relationship to campaign spending. The theoretical exploration suggests that the effect of change in composition should vary with change in the balance of campaign spending, with magnitude increasing in the relative imbalance. I use the Bonica (2013*a*) compilation of Federal Election Commission data and calculate the spending advantage of the Republican candidate in each contest and year.[13] For the 2006 to 2010 comparisons, I calculate the change in the Republican spending advantage from 2006 to 2010. Positive numbers indicate that the Republican candidate in 2010 had a greater advantage over (or lesser disadvantage to) the Democratic opponent in 2010 relative to that advantage (disadvantage) in 2006, while negative numbers indicate the reverse. Because the 2008 to 2010 comparison is from the presidential contest in 2008, where I do not have congressional district spending numbers, I use only the Republican's advantage in 2010 for these contest pairs. Positive numbers measured in both cases should correlate with the net benefit to the Republican candidate of change in composition across the two elections.

In Figure 5, I present the relationship of switching and turnout to the change in Republican spending advantage.[14] The values on the x-axis are the change in the Republican advantage in logged dollars. My main interest is in the relationship to the effect of turnout, but I also present

between Obama's -1.54 and McCain's 1.08.

[13] Spending for the state-level gubernatorial contests is not registered with the FEC. I collected spending for the 2006 and 2010 contests from the Florida Department of Elections http://election.dos.state.fl.us/campaign-finance/expend.asp.

[14] I divide spending in the statewide senate and gubernatorial contests by 25 to make the value more comparable to spending in each of Florida's 25 congressional districts.

the relationship to switching – likely some campaign expenditures are targeted at persuasion. Both frames present a positive relationship, but the relationship to the effect of change in composition is notably stronger.

*** Figure 5 here ***

In summary, I have presented the relationship of my estimates of the effects of switching voters and of change in composition to change in the location of the contest midpoints and to change in the balance of campaign spending. Graphical summaries both suggest the expected relationships. I turn next to evaluating both predictors in a multiple regression setting to provide point estimates of the relationships and to hold all else equal given potential correlation between candidate characteristics and campaign spending.

### The relative effects of candidates and context

The theoretical exploration suggests that change in the candidate midpoint should influence the magnitude and direction of the effect of switching voters and change in the balance of campaign spending should influence the magnitude and direction of the effect of change in composition. I estimate here a regression approximation to those theoretical relationships to see how changes in the locations of the competing candidates and changes in campaign spending influence the two factors of electoral change.

In Table 2, I present three regression models for three dependent variables. First, the net change in GOP vote share, which ranges from about -5 to about 20 points, and is the overall change in vote share (for the regression models, I have multiplied share by 100 to ease interpretation as percentage of vote). Second and third are the two components of change in GOP vote share I estimated with the Bayesian model, the effect of switching voters and the effect of change in composition, summarized by posterior medians. Note that the net change in GOP vote share is by design the sum of the change due to switching and change due to turnout, so columns two and three approximately decompose the effects in column one. For each model, I include as explanatory variables change in the location of the contest midpoint and change in GOP spending advantage, the same variables from Figures 4 and 5.[15] I mean-deviate both explanatory variables and include separate fixed effects for contests comparing 2006 to 2010 and for contests comparing 2008 to 2010; as I exclude a constant term, the coefficients for these intercepts are the average level of the dependent variable in the two sets of election years.

*** Table 2 here ***

The year fixed effects indicate that Republican candidates with average change in midpoints and average change in spending advantage gained about 9 percentage points from 2008 to 2010 and 7 percentage points from 2006 to 2010. Looking at columns two and three, of the 9 points from 2008 to 2010 almost all of it operates through the effect of composition (coefficient of 10.5) and the point estimate actually suggests *Democratic* candidates benefited from switchers by 1.5 percentage points 2008 to 2010, though that second effect is not statistically significant. In contrast, the average shift to the Republicans from 2006 to 2010 was much more about switching voters, about 5 percentage points versus 2 percentage points from composition.

The intercepts present the decomposition of electoral change due to switching and composition on average, while the coefficients on the midpoint and spending variables indicate the marginal effect of these variables. For overall vote share, both variables are of substantive importance, with a one-unit increase in the location of the midpoint between the candidates decreasing GOP vote share by 5 percentage points and a one-unit increase in GOP spending advantage worth 2 percentage points. The observed standard deviations of these two variables in these contests are 0.4 and 2.0, suggesting that a one standard deviation change in the location of the midpoint changes vote share by about 2 points, and a one standard deviation change in the relative balance of logged candidate spending changes vote share by about 3.5 points.

Note that without the Bayesian model and estimates of the two factors, we would be left with the results in column one and unable to understand through what mechanism of electoral change candidates and spending influence vote share. With the data compilation and model here, I am able to more specifically explore the implications of political science theories. Turning to columns

[15] As before, change in spending for contests from presidential 2008 to 2010 are just the spending balance in 2010.

two and three, the two explanatory variables appear to operate through the mechanisms I derived above. The effect of the change in midpoint operates entirely through the effect on the net benefit from switching voters (coefficient of -5.2 vs 0.0). The effect of spending operates almost entirely through its effect on the net benefit from change in composition (coefficient of 1.7 vs 0.1). While these point estimates are not particularly precise, it does suggest that candidates and campaigns are more effectively turning advantages in resources into advantages from turnout than into persuading voters to switch between the parties, at least in these contests and years.

In summary, the regression results confirm two important features of American elections. First, the electorate appears responsive to the characteristics of candidates. Even after accounting for average changes in candidates and electorate preferences (the election year fixed effects), variation in change in the midpoint between the candidates predicts the magnitude and direction of the switching voters. While I have not explained all of the variation, this simple model accounts for about 40 percent of the variance of the net effect of switching voters ($R^2$ statistic in column two, Table 2). Second, campaign spending advantage not only mobilizes voters, but mobilizes them to partisan advantage. While the effect of turnout is dominated by the average effect from 2008 to 2010, I find that change in Republican spending advantage translates into change in the number of votes Republican candidates win from voters who turn out in only one of the two elections. Voters respond both to the characteristics of the candidates who run, and to the efforts expended by their campaigns.

## Discussion and conclusion

In this article, I have shown theoretically and empirically that the partisan consequences of switching voters and of changes in composition vary across elections. These effects depend not only on the nature of the times, but on the characteristics of the candidates in the contest and on the resources expended. The effects I estimate in these contests are of electoral importance. On average, the net effect of swing voters was more than 4 percentage points of vote share. The effect of change in composition averaged more than 8 points. These effects vary notably across contests in ways partially explained by changes in candidates and context.

The answer to the question do candidates win elections by persuading swing voters or mobilizing supporters, is "it depends." On average, the effects of changes in composition are about twice as large as the effects of switching voters across the election pairs I consider. But my results clarify that switching can be a large factor in many elections and depends upon the candidates who contest that election. The results also show that, while surge and decline (Campbell, 1960) from presidential to midterm elections presents an opportunity for large partisan effects, the nature of the contest conditions the size of that effect. The effect of surge and decline is not universal.

These results suggest that voters are responsive to the local characteristics and context of house contests. While there are broad national shifts in preferences across election years, the characteristics of the candidates who run are central. Further, even within a comparison of a highly salient presidential election to a lower-turnout midterm, I find an important influence of the relative balance of campaign spending. Understanding the specifics of each contest and the features of campaign effort are an important component in understanding the meaning and implications of electoral change.

Methodologically, I have presented a statistical model to estimate counts of the individual behaviors of electoral change using only election returns and administrative data. While surveys have been used to understand how electoral change operates, and why some individuals are more and less likely to switch votes between the parties or more or less likely to vote across elections, election-level data is under-studied for these questions. Further theoretical and statistical models should be developed to explore the full range of implications that can be observed from the behavior represented by election statistics. The basic design of my statistical model could also be applied in other settings to integrate individual and place level characteristics in a unified statistical framework to estimate individual behavior from ecological or mixed data. One opportunity is to extend the model I have applied contest by contest to account for the hierarchical correlation of multiple contests in each precinct to describe electoral change not only between but within elections – split-ticket behavior.

The results highlight the importance of strategic choices by political elites. First, the set of candidates who run has implications for the likely effect of swing voters, and therefore also for the potential effectiveness of persuasion campaigns on each side. Second, campaign resources are related to the net effects of mobilization. Raising and spending money appears to be a large part of the effects of changes of turnout on vote share that candidates and interested groups should not ignore.

I have set aside the complication that the set of candidates contesting any election is likely endogenous to the state of the district in that election, the nature of the times more generally, and probably even to the set of candidates who contested the previous election. Thus, the reduced form regression results I present are observed at the end of a long set of strategic choices, which may undermine interpretation of the coefficients as causal effects. I have also not considered variation in type and mode of campaign effort, which could be a productive approach to understanding the individual basis and operation of electoral change.

My results suggest a dynamism to American elections with the interplay of candidates and voters varying across time and place. These election dynamics should be explored with more careful attention to local context to understand how the American citizenry responds to the candidate choices presented to them, and what implications these responses have for the direction of government policy and the nature of campaigns and representation.

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Table 2: Effects of candidate and context on switching and turnout

| | Net change in GOP share | Effect of switchers | Effect of composition |
|---|---|---|---|
| Change in midpoint | $-5.2^{\dagger}$ | $-5.2^{\dagger}$ | $-0.0$ |
| | (2.9) | (2.8) | (2.4) |
| Change in GOP spending advantage | $1.8^{**}$ | 0.1 | $1.7^{***}$ |
| | (0.5) | (0.5) | (0.4) |
| 2008 to 2010 comparison | $9.0^{***}$ | $-1.5$ | $10.5^{***}$ |
| | (1.0) | (1.0) | (0.8) |
| 2006 to 2010 comparison | $6.6^{***}$ | $4.9^{**}$ | 1.7 |
| | (1.6) | (1.5) | (1.3) |
| $N$ | 31 | 31 | 31 |
| $R^2$ | 0.8 | 0.5 | 0.9 |
| adj. $R^2$ | 0.8 | 0.4 | 0.9 |
| Resid. sd | 4.6 | 4.5 | 3.7 |

Standard errors in parentheses

$^{\dagger}$ significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

*Note: Dependent variables are observed net change in GOP vote share, estimated net effect of switching voters on GOP vote share, and estimated net effect of change in composition on GOP vote share. Each observation is one contest pair in one combination of two elections. Change in midpoint and change in spending advantage are both mean-deviated. Spending advantage measured in logged dollars.*

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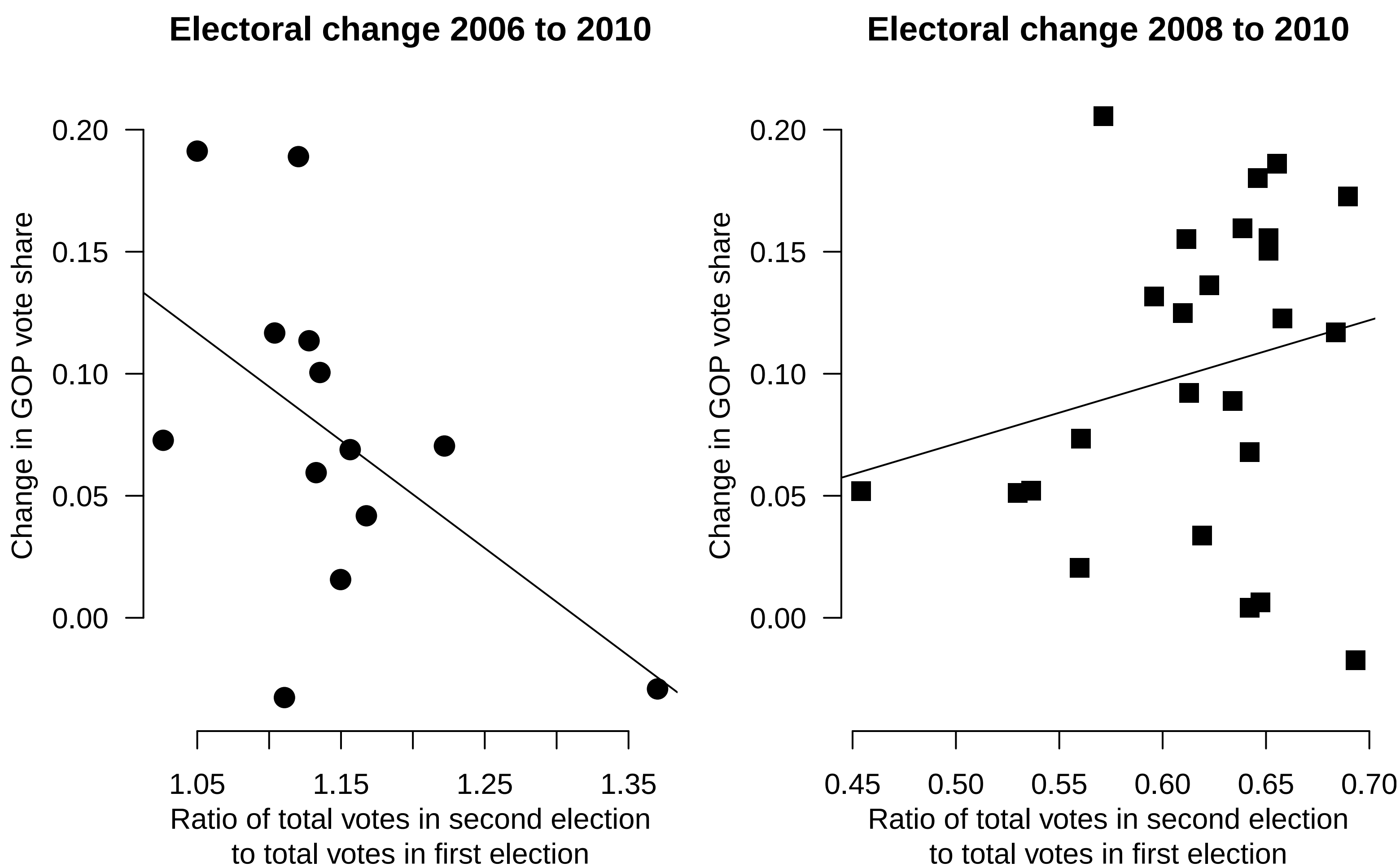
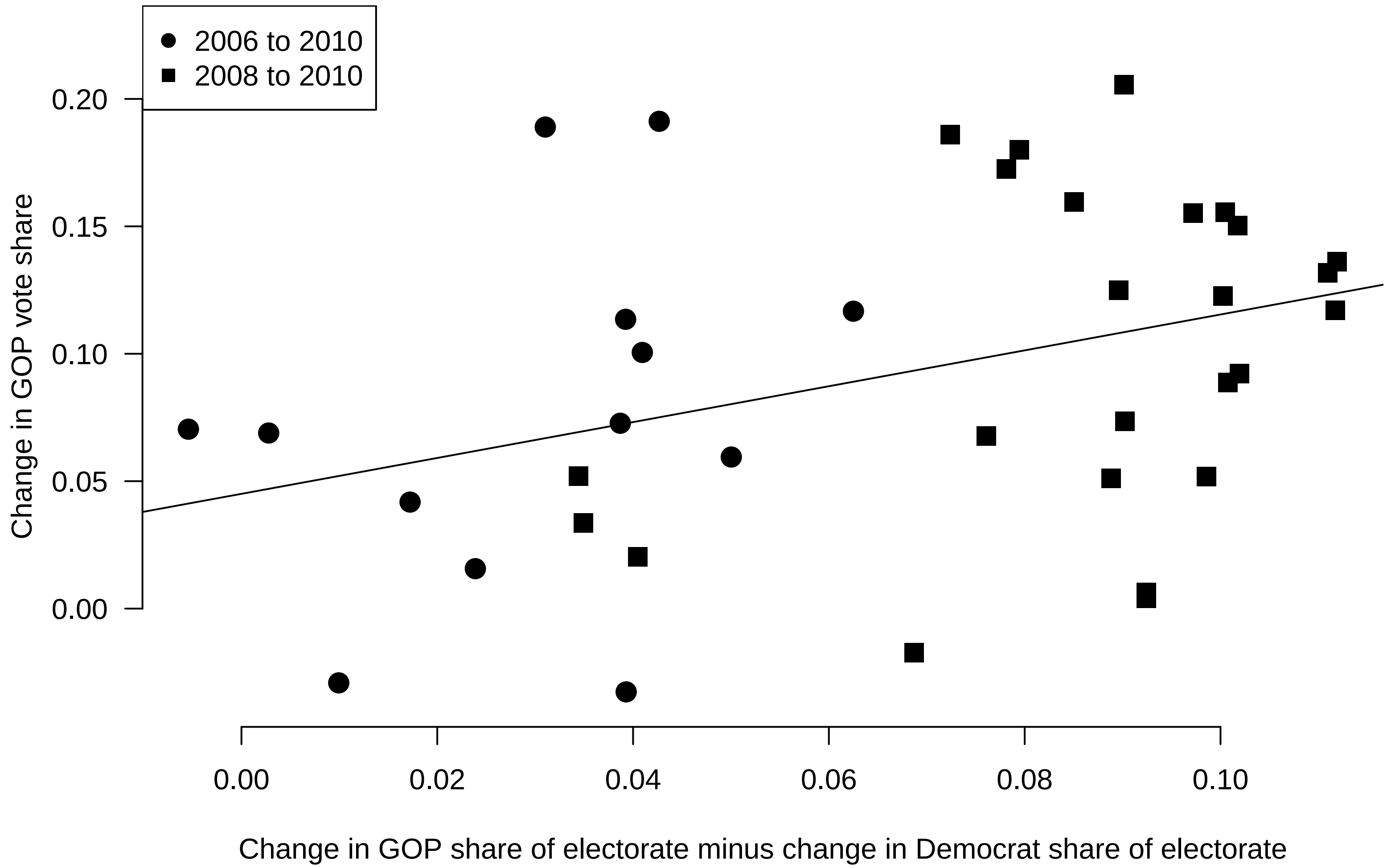
Figure 1: Change in Republican vote share versus change in turnout by contest and election pair



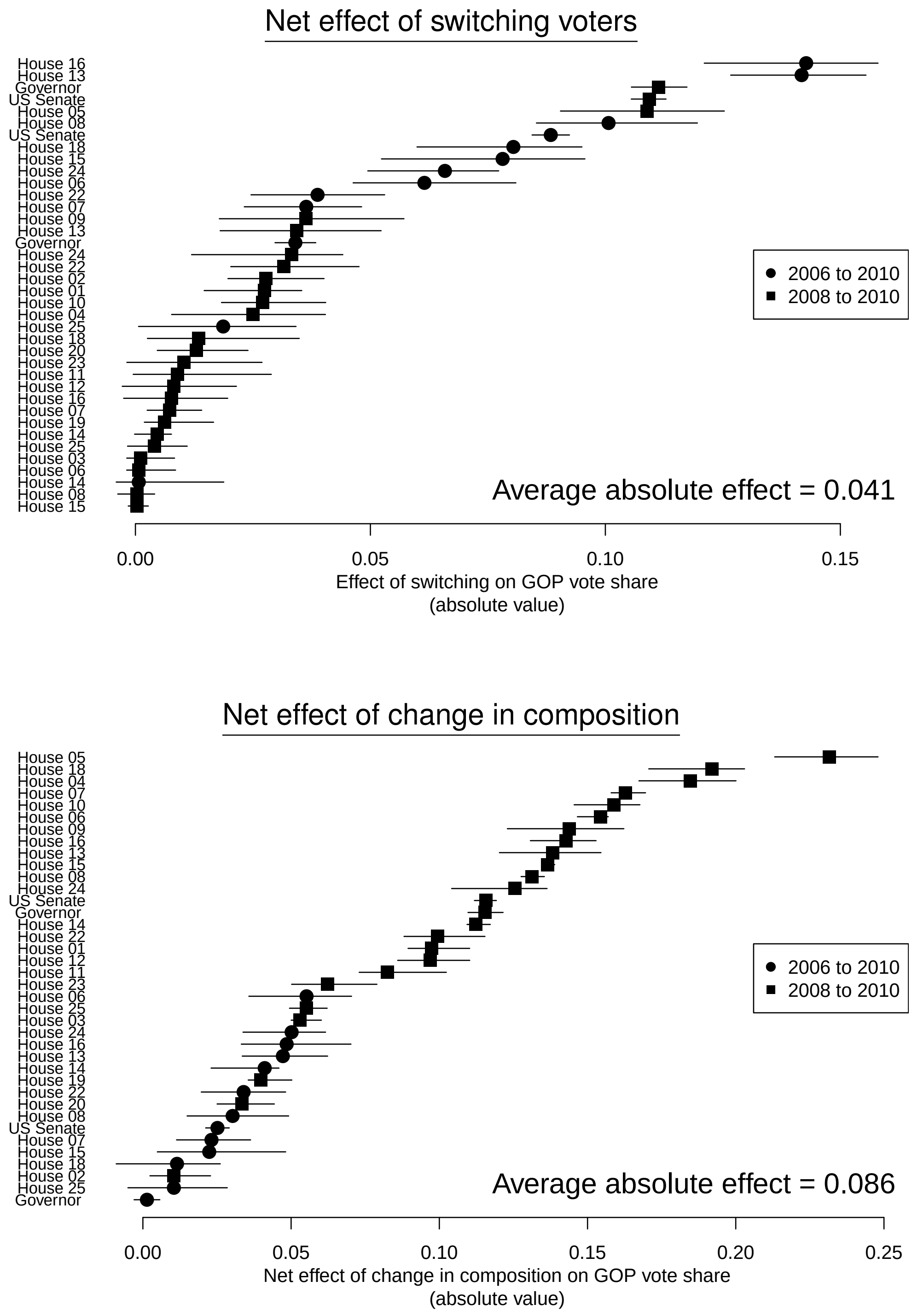

*Note: Each point is one contest election-pair. Y-axis is change in Republican candidate share of all votes cast. X-axis measures change in turnout by the ratio of the votes cast in the contest in the second election to the votes cast in the contest in the first election. Lines are OLS fit. Figure shows that change in turnout is not consistently related to the advantage of one party.*

Figure 2: Change in Republican vote share versus change in Republican advantage in turnout



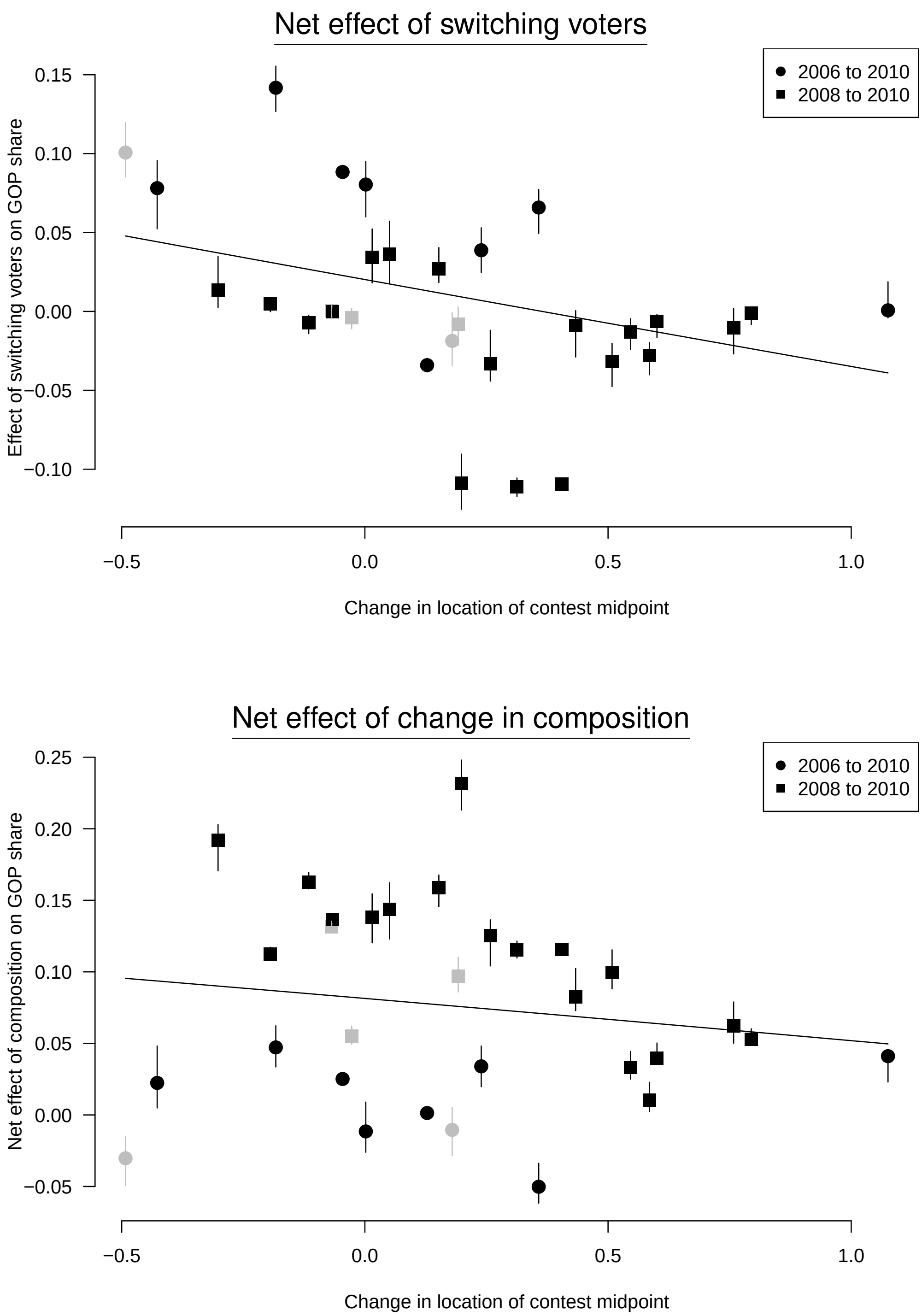

*Note: Each point is one contest pair from 2006 to 2010, or presidential vote 2008 to that contest in 2010. Y-axis is change in Republican candidate share of all votes cast. X-axis is the change in the proportion of each electorate registered Republican minus the change in the proportion of each electorate registered Democrat calculated by the author from the voter file. Larger values indicate greater advantage to the Republicans. Line is OLS fit.*

Figure 3: Distribution of the effects of switching voters and change in composition on vote share



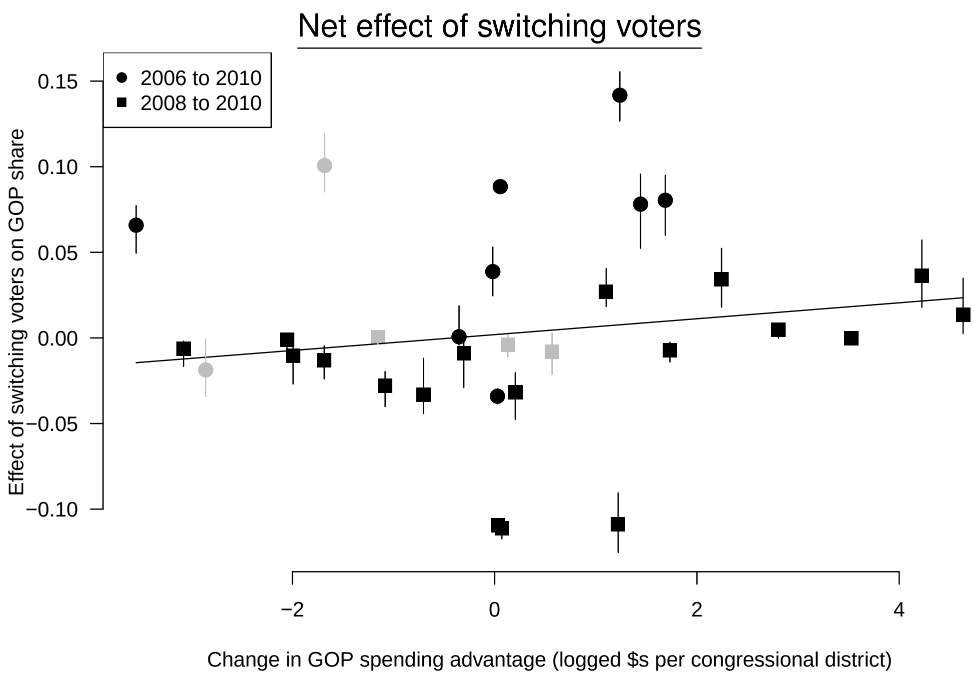

*Note: Net effect of switching voters is the contribution to GOP vote share at the second election from citizens who turned out twice and switched their votes between the parties. The net effect of change in composition is the contribution to GOP vote share in the second election from changes in the size and vote choices of citizens who participate in only one election or the other. Error bars extend to 95 percent credible intervals.*

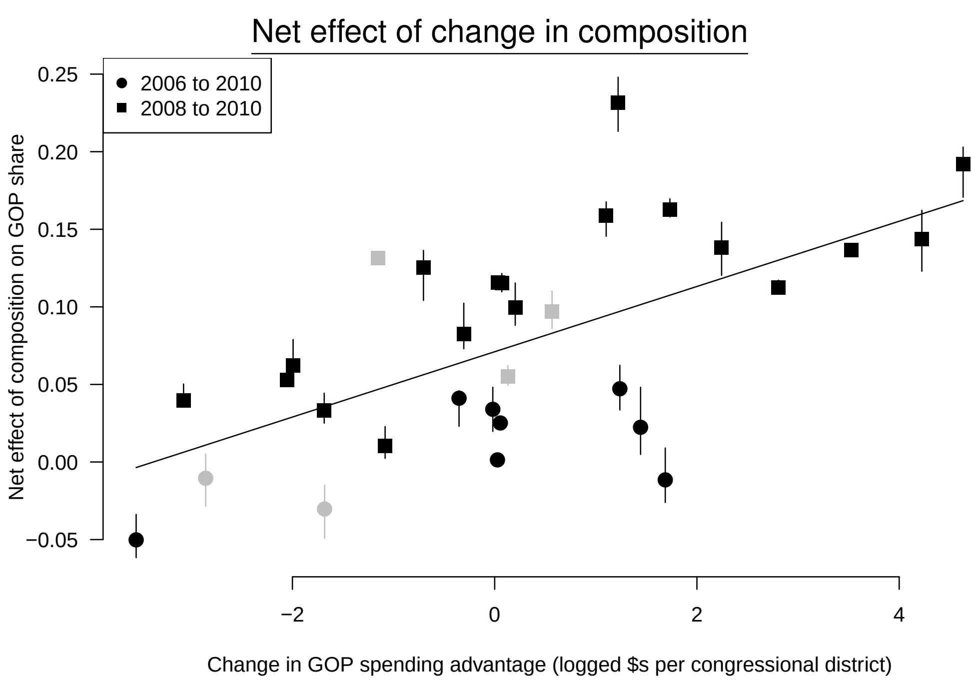
Figure 4: Relationship of switching voters and net turnout to change in contest midpoints




*Note: Change in the contest midpoint measured by Bonica CFScores (Bonica, 2013*a,b*); increasing values means that the midpoint moved to the right, decreasing values to the left. Gray points are contests that include a Tea Party candidate in addition to a Republican candidate. Error bars extend to 95 percent credible intervals.*

Figure 5: Relationship of switching voters and turnout to change in campaign spending




*Note: Change in campaign spending is in logged dollars Republican advantage; increasing values means the Republican was increasingly advantaged in spending in the second election. Gray points are contests that include a Tea Party candidate in addition to a Republican candidate. Error bars extend to 95 percent credible intervals.*

# Appendix

## A Derivation of the effects of switching voters and change in composition

In this section, I derive the effects of switching voters and change in composition on party vote share across elections from the internal cell counts of Table 1. The sum of these two effects equals the change in the vote margin as a proportion of 1 across the two elections.

First, for parsimony in notation define the size of the two electorates as $T_1$ and $T_2$, with $T_1 = (n_1 + n_2 + n_4 + n_5 + n_7 + n_8)$ and $T_2 = (n_1 + n_2 + n_3 + n_4 + n_5 + n_6)$, the number turning out in election one and two. Then, Republican vote share at election one is $(n_1 + n_4 + n_7)/T_1$ and at election two is $(n_1 + n_2 + n_3)/T_2$. The outcome of interest is change in this share, $(n_1 + n_2 + n_3)/T_2 - (n_1 + n_4 + n_7)/T_1$. If turnout were equal in the two elections, then electoral change would be trivially $(n_2 - n_4) + (n_3 - n_7)$, with the first quantity the number of switchers to the Republican minus the number of switchers away from the Republican, and the second quantity the net gain in votes for the Republican from those who voted in only one election or the other. Because turnout varies, and varies considerably enough not to allow assuming it away, I proceed to derive both effects allowing for change in composition.

First, define the effect of change in composition as the change in vote share due to all changes *except* switching. That is, attribute both change in the denominator $(T_2 - T_1)$ and change in the rate at which single-election voters vote for the Republican $[n_3/(n_3 + n_6) - n_7/(n_7 - n_8)]$ to the effects of composition. This counterfactual can be calculated by assuming none of the voters who turned out at both election switched their votes. In other words, to calculate the effect of change in composition, assume that Republican votes from the set of voters who voted in both election is $n_1 + n_4$ for both election one and election two. This means that the effect of composition of the electorate is

$$\frac{n_1 + n_4 + n_3}{T_2} - \frac{n_1 + n_4 + n_7}{T_1}. \tag{A1}$$

The first quantity is the Republican vote share at election two if there is no switching but if turnout changes proceeded as observed, the second quantity is Republican vote share at election one. The net effect of changes to both the numerator and the denominator is the effect of change in composition.

The effect of switching voters is the remaining change in vote share not due to these two effects of turnout. Specifically, take away the voters who turned out in both elections but switched away from the Republican $n_4$, and add the voters who turned out in both elections and switched to the Republican $n_2$. This makes the effect of switching voters

$$\frac{n_1 + n_2 + n_3}{T_2} - \frac{n_1 + n_4 + n_3}{T_2}. \tag{A2}$$

The quantities in Eq. A1 and A2 serve as the outcomes of interest. Because the internal cell counts $n_1$ to $n_8$ are estimated using Markov chain Monte Carlo (MCMC) methods, I summarize posterior beliefs about the two effects by calculating each given the estimates of the internal cell counts on each MCMC iteration. The distribution of the calculations across all MCMC samples summarizes the posterior distribution of the effects of switching and of changes in composition.

## B Bayesian hierarchical model of electoral transitions

In this section, I present the hierarchical model to estimate the unobserved two-election behaviors of individuals in each election. I use Bayesian methods to estimate these quantities, and so also present the specification of priors over each relevant parameter. The model is an extension of the ecological inference model developed in Wakefield (2004).

Assume that each precinct $i$ contains a total of $N_i$ eligible voters across two elections. These $N_i$ voters cast $c_i^1 + c_i^2$ votes in election $c$ and $r_i^1 + r_i^2$ votes in election $r$ for choices 1 and 2, with vote counts observed and $c_i^3 = N_i - c_i^1 - c_i^2$ and $r_i^3 = N_i - r_i^1 - r_i^2$ (observed) non-vote counts in elections $c$ and $r$.

Each individual makes one choice in election $c$ and one choice in election $r$. Let the vector $\boldsymbol{n}_i$ of length 9 capture the count of voters who make each combination of behaviors across the two elections in precinct $i$. In Figure A1, I represent these counts inside a $3 \times 3$ matrix where the rows correspond to behavior in election $r$, the columns to behavior in election $c$, and each internal cell represented by $n_1$ through $n_9$ represents a two-election behavior. It is the counts $\boldsymbol{n}_i$ that are of estimation interest. Functions of those cell counts reveal features of electoral change between election $c$ and election $r$. For example, cell $n_1$ is the count of eligible voters who makes choice $r^1$ and $c^1$ and cell $n_2$ is the count of eligible voters who makes choices $r^1$ and $c^2$. These cells might represent voting twice for the Republican candidate versus switching from the Republican to the Democrat.

Figure A1: Table of behavioral counts across two elections

| | | | |
|---|---|---|---|
| $n_1$ | $n_2$ | $n_3$ | $r^1$ |
| $n_4$ | $n_5$ | $n_6$ | $r^2$ |
| $n_7$ | $n_8$ | $n_9$ | $r^3$ |
| $c^1$ | $c^2$ | $c^3$ | $N$ |

*Note: Table index $i$ suppressed from all quantities for presentation.*

The observed row and column totals $\boldsymbol{r}_i$ and $\boldsymbol{c}_i$ provide constraints on the counts that the unobserved internal cell values can take, but these bounds are not usually very informative. To narrow the estimates of the cell values $\boldsymbol{n}_i$, I assume the counts are a multinomial draw given precinct specific probabilities, and that those probabilities are stochastic functions of precinct characteristics and related across precincts. This allows me to pool observations to make estimates of the internal counts while maintaining consistency with the bounds provided by the observed row and column totals.

Let the 9-vector $\boldsymbol{p}_i$ describe the probabilities that each eligible voter in $N_i$ chooses the two-election behavior represented by each interior cell, with $\sum_j p_i^j = 1$. The 9-vector $\boldsymbol{n}_i$ is the set of counts realized in this election pair for each two-election behavior in precinct $i$, and is a multinomial draw given probability vector $\boldsymbol{p}_i$ and $N_i$. To maintain the observed row sums, draw the cell counts $\boldsymbol{n}_i$ from the estimated cell probabilities $\boldsymbol{p}_i$ by row in three separate multinomial draws and constrain the column totals $c_i^1$, $c_i^2$, and $c_i^3$ generated by $\boldsymbol{n}_i$ to match the observed column totals (as in Wakefield, 2004). Formally,

$$\begin{aligned}
(n_{i1}, n_{i2}, n_{i3}) &\sim \text{Multin}(r_i^1,\ (p_{i1}, p_{i2}, p_{i3})) \\
(n_{i4}, n_{i5}, n_{i6}) &\sim \text{Multin}(r_i^2,\ (p_{i4}, p_{i5}, p_{i6})) \\
(n_{i7}, n_{i8}, n_{i9}) &\sim \text{Multin}(r_i^3,\ (p_{i7}, p_{i8}, p_{i9})) \\
c_i^1 &= n_{i1} + n_{i4} + n_{i7} \\
c_i^2 &= n_{i2} + n_{i5} + n_{i8} \\
c_i^3 &= n_{i3} + n_{i6} + n_{i9}
\end{aligned}$$

In practice, the column total constraints are achieved by returning a data likelihood of zero when any of the drawn column sums are inconsistent with the observed column sums. Note that this top level of hierarchy accounts for potential sampling variability with the size of $r_i^1$, $r_i^2$, and $r_i^3$ across precincts.

The second level of the hierarchy models the unobserved cell probabilities $\boldsymbol{p}_i$ as functions of precinct characteristics $\boldsymbol{x}_i$. I let each cell probability $p_i^j$ arise through a multinomial logit link such that,

$$p_i^j = \frac{exp(\boldsymbol{X}[i,j,]'\boldsymbol{\beta}[i,j,])}{\sum_{k=1}^{9} exp(\boldsymbol{X}[i,k,]'\boldsymbol{\beta}[i,k,])},$$

where $\boldsymbol{X}$ is a three-dimensional ragged array with dimensions precinct $i$, cell number $j$, and set of covariates. Each element of $\boldsymbol{X}$ is one of the full set of covariates $\boldsymbol{x}_i$ that is relevant to choice $j$, with the set of covariates potentially distinct across choices. $\boldsymbol{\beta}$ is a ragged array that matches the dimensions of $\boldsymbol{X}$, with each element a coefficient to be estimated mapping that precinct covariate to that precinct's choice probability $p_i^j$ through the multinomial logit link.

I allow the $\boldsymbol{\beta}$ to vary across precincts hierarchically as random coefficients with means $\boldsymbol{\alpha}$ and variances $\boldsymbol{\Sigma}$, and prior distributions over $\boldsymbol{\alpha}$ and $\boldsymbol{\Sigma}$,

$$\begin{aligned}
\boldsymbol{\beta}[i,j,k] &\sim N(\boldsymbol{\alpha}[j,k], \boldsymbol{\Sigma}[j,k]) \\
\boldsymbol{\alpha}[j,k] &\sim N(b0, B0) \\
\boldsymbol{\Sigma}[j,k] &\sim U(a,b),
\end{aligned}$$

with hyperparameters $b0$, $B0$, $a$, and $b$ the prior mean and variance for the choice coefficients, and the prior minimum and maximum for the uniform distribution over the variance of the random effect distribution. These could be indexed by choice and covariate, but in practice I use diffuse priors constant across both.[16]

The random coefficients are a flexible approach to allowing precinct characteristics to influence where within the bounds the cell counts are estimated. If the data suggest some relationship across precincts in the way characteristics map to cell counts, the coefficients can provide that. If some precincts are more consistent than others with the precinct characteristics, the random coefficients

[16] Note that as $\boldsymbol{\Sigma}[j,k]$ approaches zero, the model becomes constant coefficients rather than random effects, which could be constrained via the prior over $\boldsymbol{\Sigma}$ or could be estimated from the data as long as the hyperparameter $a$ is sufficiently close to zero.

also allow that relationship to be represented.

## C Statistical model performance

In order to evaluate the performance of the statistical model, I present in this section results from a simulation study. As a first benchmark, I simulated precinct $3 \times 3$ electoral change transitions for 250 precincts with an average total count of 200, and 4 covariates influencing the counts of each of the 9 cells of the table. I simulated 30 data sets. Only one factor varied across the simulations, other than sampling variation: I gradually increased the hierarchical variance in the relationship between precinct covariates and cell counts. That is, the first simulation had cell counts more closely predicted by covariates than the last simulation, with the hierarchical variation increasing by 0.01 on each simulation.

Figure A2 presents results from the basic simulations. The figure plots estimated precinct cell counts (represented by the posterior median) against their actual values.[17] The posterior medians closely track the true values as indicated by their clustering around the dotted 45 degree line. The overlaid loess smoother (solid green) shows no systematic deviations across the range of internal cell magnitudes. This result suggests that the estimation strategy generates unbiased estimates. With respect to uncertainty, 92.1 percent of the posterior 95 percent credible intervals contain the true value, which suggests some understatement of uncertainty about the internal cell counts of each precinct.[18] However, for the simulations I did not burn in the Markov Chain as long as for the values presenting in the paper (for reasons of computation time), with adaption phase and burnin of 1,000 iterations each as compared to a burnin period of 200,000 iterations for the results in the paper.

To evaluate the relationship between table size and model performance, I ran 10 additional simulations varying the average size of the table, as summarized in Table A1 below. There is a negative relationship between the table size and coverage of posterior intervals. The point estimate from an OLS regression at the cell level yields a coefficient of -5.4e-5 meaning that increasing the number of voters in a precinct tabulation by 1,000 decreases the accuracy of the posterior credible interval by about 5 percentage points. As can be seen from Table A1, however, the relationship is noisy, with some simulations with large precinct sizes getting better coverage than other simulations with small precinct sizes. As before, the sampler did not adapt and burn in as long as in the main body of the paper due to computer time constraints.

## D Details of data set construction

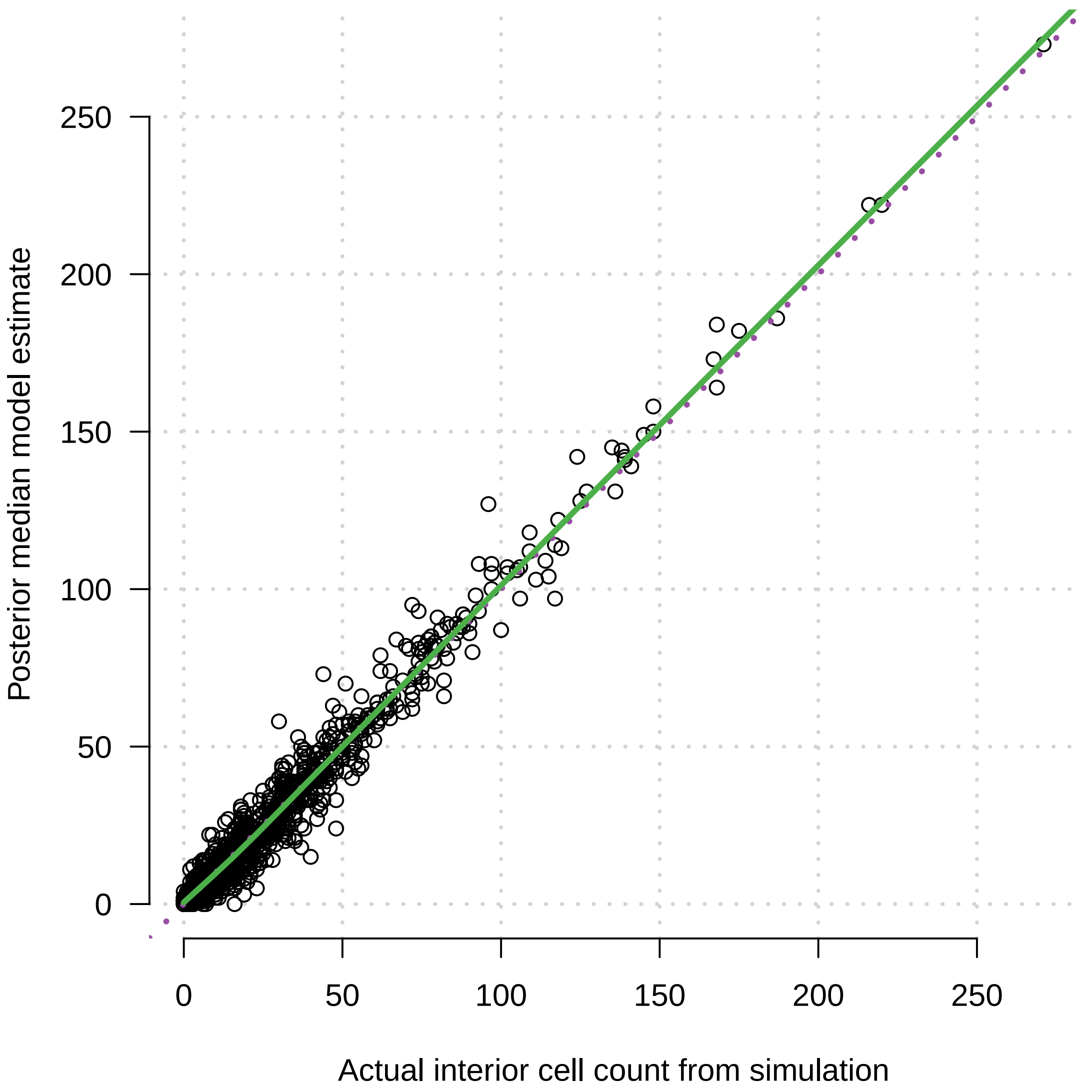
To construct precinct-level observations of vote returns and characteristics from the voter file, I merged together these two sources of data. The resulting data set has observations from each of two elections both on candidate vote totals and on counts of registrants who voted in one, both, or the other election, and their parties of registration.

Because precinct boundaries may change across elections, I first created common precincts that encompass the same set of residential addresses in each of the two elections. To do so, I took statewide voter files produced shortly after each election (2006, 2008, and 2010). I then cross-joined the two files by address string to match precinct at election one to precinct at election two

[17] Note that precinct counts may be a conservative benchmark because most quantities in the main text are aggregates across many precincts, likely mitigating sampling and other random error.

[18] Interval coverage is negatively related to hierarchical between-unit variance based on a regression of cell inside interval on hierarchical variance parameter.

Figure A2: Simulated internal cell counts versus actual




*Note: Each point is the posterior median estimate for one interior cell count in one precinct in one simulation (y-axis) plotted against the true value of the cell count (x-axis). Points are a random sample of 1000 cells across simulations and tables. The dotted line is a 45 degree line on which perfectly estimated cell counts should fall. The solid green line is a loess smoother through the points, showing no systematic pattern to residuals.*

Table A1: Interval coverage for varying precinct sizes

| Average table size | Proportion in 95 percent credible interval |
|---|---|
| 100 | 0.91 |
| 107 | 0.98 |
| 127 | 0.92 |
| 170 | 0.9 |
| 248 | 0.84 |
| 376 | 0.97 |
| 570 | 0.76 |
| 849 | 0.94 |
| 1233 | 0.68 |
| 1744 | 0.92 |

by address. That is, if at the first election the address 123 Main Street, Miami voted in precinct DAD-123, and in the second election the address 123 Main Street, Miami voted in precinct DAD-321, I match the vote totals from precinct DAD-123 at election one to the vote totals of precinct DAD-321 at election two. If, however, the address 345 Main Street voted in precinct DAD-123 at election one but precinct DAD-654 at election two, then I also match DAD-654 to DAD-123 across the two elections. In some cases, therefore, the common precinct across elections encompasses multiple precincts from the same election. For the 2006 to 2010 data, I started with 6968 precincts from 2006 and 7201 precincts in 2010, and aggregated them into 6316 common precincts. For the 2008 to 2010 data, I started with 6990 precincts from 2008 and 7201 precincts in 2010, and aggregated them into 6733 common precincts.

With each registrant in each election placed into a common geographic boundary, I then matched individual registrants across elections to identify the voters who participated in both elections in the same common precinct.[19] I sequentially match registrants by decreasingly-specific identifiers. The voter file includes for each registrant a voter id number, which in most cases identifies the same individual across elections. In some cases, when a registrant moves or changes their registration for some other reason, the voter id does not follow the updated record, and so for these registrants I must match based on alternative characteristics. I use first and last name, date of birth, and geography to do so. For each election pair, the sequential match proceeded as follows. First, I take all of the registrants from the first voter file in the election pair and attempt to match each to a registrant in the second voter file in the same county with the same voter id, first name, and date of birth – I do not match on last name in an effort to capture individuals who have changed their last name through marriage. Second, I take all of the registrants from the first voter file who did not match at the first stage, and attempt to match each to a registrant in the second voter file within the same election precinct and with the same first name, last name, and date of birth. Third, I take all the registrants from the first voter file who did not match at the first or the second stage, and attempt to match each to a registrant in the second voter file within the same county and with the

[19] Because statewide voter files record only current geography and party of registration for registrants, constructing over-time measurements requires merging across voter files obtained at different points in time.

same first name, last name, and date of birth. Fourth, I take all the registrants from the first voter file who did not match at the first, second, or third stage, and attempt to match each to a registrant in the second voter file with the same first name, last name, and date of birth who resides outside of the county of the registrant in the first voter file. Finally, I merge to the file all the registrants from the second voter file who did not match to any registrant in the first voter file, yielding a final data set encompassing the union of registrants from the two files and matched records across time.[20]

Overall, I successfully match 10.0 of 14.0 million registrants in the union of the 2006 and 2010 electorates (71.2 percent), and 11.9 of 13.1 million registrants in the union of the 2008 and 2010 electorates (90.7 percent). Of the successful matches, I matched 93.7 and 98.0 percent, respectively, on voter id at the first stage of the matching procedure. There are 2.5 and 0.6 million new, unmatched registrants in the second voter files in the two matches.

With individual registrants matched across the two elections, I then create precinct-level measures of the electoral behaviors at each election. I count the number of registrants who voted twice, who voted only in the first election, who voted only in the second election, or who did not vote in either election. I make these counts separately for those who were registered Democrat in both elections, those registered Republican in both elections, and others. Thus, for each precinct, I can describe what proportion of the electorate across the two elections was, for example, registered Democrat and voted twice, registered Republican and voted only in the second election, and so forth.

To the characteristics of the precinct electorate, I merge precinct vote totals. I gathered precinct election returns from the Florida House of Representatives' Redistricting Committee (`http://mydistrictbuilder.wordpress.com/opendata/`), which compiled statewide precinct election returns from the 2006, 2008, and 2010 general elections for purposes of 2010 Census redistricting. The data include state house, state senate, U.S. house, U.S. senate, and statewide executive offices for 2006 and 2010, and presidential totals only for 2008.[21] I match election returns by precinct and election to precinct names in the voter files in each election, and then aggregate vote totals up to the common precinct for each election pair.

After the merging and aggregation, the data set for each election pair consists of a set of precincts with candidate vote totals from each election, and with characteristics of the union of registrants who participated in one election or the other. After creating one common precinct for all leftover votes and registrants not placed in a matched precinct, I have 6,316 common precincts with vote totals and registrant characteristics for the 2006 to 2010 election pair, and 6,733 common precincts for the 2008 to 2010 election pair.

One final complication is that the number of votes recorded in the precinct is rarely equivalent to the number of votes cast in the precinct election returns. This is due to spoiled ballots, missing or purged records in the voter file, etc. The match is generally close, but not enough for the data to exactly identify the size of the full electorate ($\sum_{i=1}^{9} n_i = N$) in each precinct. Because the vote totals from the precinct election returns form the margins for columns one and two and rows one and two in Table 1, the size of the electorate $N$ must be large enough to account for the number of abstainers in each election, row total three and column total three. I take the conservative approach in defining the size of the electorate with the following algorithm, which is likely larger than the

[20] I drop registrants who match to multiple other registrants across files because I do not know which registrant goes with which. This is a small proportion of the total electorate, on the order of 0.5 percent of the union of the two electorates.

[21] The 2006 data do not include all U.S. house contests, an absence for which I could not find documentation.

actual size of the precinct electorate.[22] First, from the voter file data I calculate the ratio of the total number of registrants observed at the two elections to the ratio of the total number of votes at the two elections. The total number of registrants is the number registered in the precinct in the first election plus the number registered in the precinct in the second election minus the number matched as the same individual in the precinct. The total number of votes at the two elections is the sum of the registrants recorded to have voted in the precinct in the first election plus the sum of the registrants recorded to have voted in the second election. The ratio is the voter file measure of the ratio of registrants to votes cast. I multiply this ratio by the number of votes cast in the precinct per the precinct election returns. This product is an approximation of the number of eligible voters in the precinct across the two election consistent with the number of votes observed from the vote data. In cases where the product is less than the total precinct votes in either election (e.g., when the ratio is less than 1), I set the total to the greater number of precinct votes observed across the two elections.

This estimate of the size of the electorate serves as the total table size in each precinct, and the totals for row three and column three, the number abstaining in each election, is this size of the electorate minus the votes cast in the row or column election. I am likely over-estimating the size of the total eligible electorate and thus the number of abstainers, because many records in the voter file are registrants who have moved, re-registered, passed away, or I failed to match across files. But because the row and column totals bound the sizes of the cells in column three and row three, my experience in practice is that the model puts a large count of registrants in $n_9$.

## E Summary of contests

In Table A2, I present the contests of this analysis. I present the years of the two elections and the contest from the first and second elections, the number of (common) precincts with observed vote totals, and the Republican vote share from each contest in these observed precincts.

## F Details of Markov chain Monte Carlo estimation

I estimate the Bayesian hierarchical model for each contest pair with voter file data as explanatory variables. For each estimation, I use the `JAGS` statistical software, which implements slice and Gibbs sampling to create Markov chains for each parameter in the model. I burn in the samplers for 200,000 iterations, and then draw samples every 30 iterations for 300,000 iterations, for a total of 10,000 posterior samples of each parameter. Code for the model is available from the author on request.

I use diffuse priors for the means and variances of the hierarchical coefficient distribution with mean-vector $\boldsymbol{\alpha}$ and variance matrix $\boldsymbol{\Sigma}$. The prior mean and variance over all elements of $\boldsymbol{\alpha}$, $b0$ and $B0$, are set to 0 and 10. I set the prior minimum and maximum for the uniform distribution over each diagonal element of the standard deviation matrix $\boldsymbol{\Sigma}$ to .001 and 3. These values are the standard deviation for the distribution of random coefficients across precincts, which will be centered at the appropriate element of $\boldsymbol{\alpha}$.

In addition to monitoring the table cell counts, $n_1$ to $n_9$ for each precinct in each contest, I also monitored the regression coefficients mapping voter file variables to each cell. I mapped to the four cells describing behavior of two-election voters the covariates describing registrants recorded

[22] Note that the voter file only defines the set of registrants at that election, and does not define the set of eligible voters including those unregistered, which is the true count of the size of the eligible electorate.

Table A2: Summary of contests used in analysis

| Year one | Year two | Contest one | Contest two | Number precincts | GOP share one | GOP share two |
|---|---|---|---|---|---|---|
| 2006 | 2010 | US Senate | US Senate | 5,603 | 39.0 | 50.4 |
| 2006 | 2010 | House 22 | House 22 | 371 | 47.1 | 54.4 |
| 2006 | 2010 | House 16 | House 16 | 276 | 47.7 | 66.8 |
| 2006 | 2010 | House 13 | House 13 | 285 | 49.9 | 68.8 |
| 2006 | 2010 | House 08 | House 08 | 231 | 52.8 | 59.8 |
| 2006 | 2010 | Governor | Governor | 5,642 | 53.1 | 49.8 |
| 2006 | 2010 | House 15 | House 15 | 169 | 56.9 | 67.0 |
| 2006 | 2010 | House 24 | House 24 | 223 | 57.9 | 59.5 |
| 2006 | 2010 | House 25 | House 25 | 142 | 58.7 | 55.8 |
| 2006 | 2010 | House 06 | House 06 | 280 | 59.3 | 71.0 |
| 2006 | 2010 | House 18 | House 18 | 215 | 61.9 | 68.8 |
| 2006 | 2010 | House 07 | House 07 | 248 | 63.1 | 69.0 |
| 2006 | 2010 | House 14 | House 14 | 249 | 64.5 | 68.6 |
| 2008 | 2010 | President | House 23 | 218 | 25.1 | 30.3 |
| 2008 | 2010 | President | House 19 | 336 | 33.9 | 37.3 |
| 2008 | 2010 | President | House 20 | 300 | 36.2 | 38.3 |
| 2008 | 2010 | President | House 11 | 216 | 37.0 | 44.4 |
| 2008 | 2010 | President | House 03 | 208 | 37.2 | 42.3 |
| 2008 | 2010 | President | House 08 | 235 | 46.7 | 59.8 |
| 2008 | 2010 | President | House 10 | 252 | 47.2 | 65.8 |
| 2008 | 2010 | President | House 22 | 385 | 47.6 | 54.4 |
| 2008 | 2010 | President | House 18 | 247 | 48.7 | 69.3 |
| 2008 | 2010 | President | Governor | 5,975 | 49.7 | 50.1 |
| 2008 | 2010 | President | US Senate | 5,963 | 49.8 | 50.4 |
| 2008 | 2010 | President | House 24 | 230 | 50.3 | 59.5 |
| 2008 | 2010 | President | House 12 | 217 | 50.6 | 59.5 |
| 2008 | 2010 | President | House 25 | 183 | 50.9 | 56.0 |
| 2008 | 2010 | President | House 15 | 244 | 51.6 | 65.3 |
| 2008 | 2010 | President | House 16 | 286 | 51.8 | 66.8 |
| 2008 | 2010 | President | House 13 | 288 | 51.8 | 69.1 |
| 2008 | 2010 | President | House 09 | 180 | 53.8 | 71.8 |
| 2008 | 2010 | President | House 07 | 268 | 53.9 | 69.4 |
| 2008 | 2010 | President | House 05 | 161 | 55.3 | 67.5 |
| 2008 | 2010 | President | House 02 | 305 | 55.8 | 54.0 |
| 2008 | 2010 | President | House 06 | 299 | 56.1 | 71.6 |
| 2008 | 2010 | President | House 14 | 257 | 57.1 | 68.8 |
| 2008 | 2010 | President | House 04 | 219 | 60.8 | 76.8 |
| 2008 | 2010 | President | House 01 | 221 | 67.1 | 79.5 |

to have voted in each election. I mapped to the two cells describing the behavior of voters only at the first election and the two cells describing the behavior of voters only at the second election measures from the voter file describing the partisan breakdown of those individuals. I use the same predictors from the voter file for every contest, though the coefficients are estimated independently across contests.

I present in Appendix Figure A3 posterior median and 95 percent credible intervals for the hierarchical means $\boldsymbol{\alpha}$ estimated for each coefficient in each of two example contests. Each row of the figure is the posterior distribution of the coefficient for that covariate, presented in sets by cell. For example, the top row is the intercept for cell $n_1$, with a posterior median of around -2.5. The reference category is cell $n_9$, the set of registrants who did not vote in either election. All covariates are mean deviated, so the intercept values can be interpreted as the contest average for that cell, relative to the large category $n_9$. Note that these parameters capture the hierarchical mean for the coefficient; for each precinct, the coefficient is a random draw from a normal distribution centered at this value. Further estimation results are available from the author by request.

# G Example precinct estimates

In Table A3, I present the median posterior estimates and 95 percent credible intervals for each cell of the cross-tabulation of electoral change behaviors from precinct 1132 in Florida's 15th congressional district. This is an example of what the model estimates for each precinct in each contest pair.

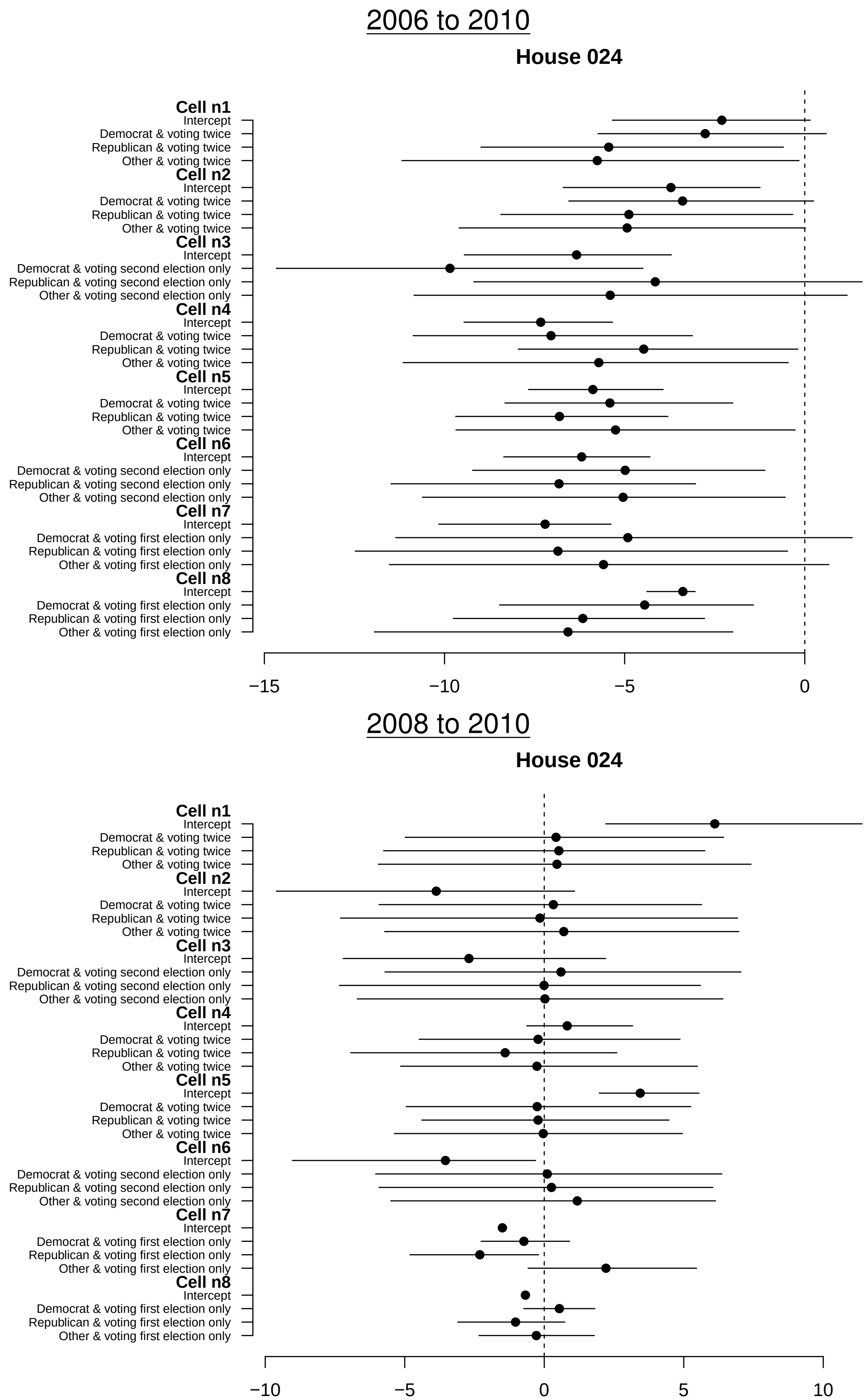
Table A3: Example estimates for precinct 1132 in Florida's 15th congressional district, 2006 to 2010

| | **Rep**$_1$ | **Oth**$_1$ | **NoVote**$_1$ | |
|---|---|---|---|---|
| **Rep**$_2$ | 548 | 113 | 73 | 736 |
| | [453,590] | [57,170] | [9,200] | |
| **Oth**$_2$ | 1 | 438 | 26 | 469 |
| | [0,32] | [349,466] | [2,115] | |
| **NoVote**$_2$ | 51 | 95 | 2736 | 2882 |
| | [1,146] | [33,199] | [2578,2815] | |
| | 603 | 643 | 2841 | |

*Note: Cell entries are posterior median estimated counts for each two-election behavior in that precinct, 95 percent credible intervals in brackets. The row and column totals are the observed counts from the election statistics and the voter file. Note that the median posterior estimates for each cell may not sum exactly to the row and column totals, but on each iteration of the algorithm these bounds hold.*

There is notable uncertainty around each cell's estimate as indicated by the 95 percent credible intervals. Because the quantities of interest are sums and differences of these estimates (e.g. $n_2 - n_4$), the bounds on those quantities are more narrow. The large size of the bottom right cell may appear unusual, but it is a function of the choice to estimate the total precinct size conservatively to allow for registrants who move between precincts across elections. In practice, because these counts are placed in row 3 and column 3, they are mostly placed in cell $n_9$, those citizens who stay home at both elections who are not of direct interest in this project.

Figure A3: Example model coefficients for Florida 24th




*Note: Excluded category is cell* $n_9$*, staying home in both elections.*