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The Effect of Differential Cognition Costs on Election Outcomes

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ABSTRACT

Who Misvotes? The Effect of Differential Cognition Costs on Election Outcomes*

If voters are fully rational and have negligible cognition costs, ballot layout should not affect election outcomes. In this paper, we explore deviations from rational voting using quasi-random variation in candidate name placement on ballots from the 2003 California Recall Election. We find that the voteshares of minor candidates almost double when their names are adjacent to the names of major candidates on a ballot. Voteshare gains are largest in precincts with high percentages of Democratic, Hispanic, low-income, non-English speaking, poorly educated, or young voters. A major candidate that attracts a disproportionate share of voters from these types of precincts faces a systematic electoral disadvantage. If the Republican frontrunner Arnold Schwarzenegger and Democratic frontrunner Cruz Bustamante had been in a tie, adjacency misvoting would have given Schwarzenegger an edge of 0.06% of the voteshare. This gain in voteshare exceeds the margins of victory in the 2000 U.S. Presidential Election and the 2004 Washington Gubernatorial Election. We explore which voting technology platforms and brands mitigate misvoting.

JEL Classification: D01, D72, D83, J10

Keywords: bounded rationality, voting mistakes, ballot design, voting technology, voter intent, electoral systems, electoral reform

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I. Introduction

In this paper, we use the quasi-random variation in layouts of 150 types of ballots used in the 2003 California Recall Election to study how different ballot designs led to systematic deviations in the voteshares of candidates. We refer to votes for a candidate that are solely attributable to that candidate's favorable position on the ballot as misvotes because differences in ballot layout should not affect the decisions of fully rational voters.[1] Previous literature has focused on position misvotes – when candidates receive more votes because they are listed first on the ballot page or column. In this paper, we consider another type of misvote: adjacency misvotes – when candidates receive more votes because they are adjacent to a popular candidate.

Adjacency misvotes can occur if voters accidentally select candidates adjacent to their preferred choices. Evidence from simulated voting experiments suggests that some voters become confused by the ballot layout and voting technology and, as a result, cast accidental but valid votes for candidates adjacent to the intended choice of the voter (e.g., Roth 1998). These adjacency misvotes are especially likely if the ballot columns are unclearly marked, the ballot text is small, the punch card grid is confusing, or if voters slip while marking their ballots. See Appendix 1 for sample ballots that may produce adjacency misvotes.[2]

Misvotes are important for two reasons. First, and at a more fundamental level, misvotes provide insight into human cognition: While Simon's (1955) seminal article has spurred much research on the limits of rational decision-making (see Conlisk 1996 for an overview), relatively few papers examine which types of individuals are most prone to behavioral anomalies. We

[1] We use rational in the traditional sense of the term: someone who has a preference ordering over candidates that is complete and transitive over the candidates. Implicit in this definition is that choice is not affected by cognition costs.

[2] It is also conceivable that adjacency misvotes can occur if voters scan quickly for popular candidates and then give increased consideration to candidates listed near the popular candidate. In Table 3, we show that accidental voting rather than increased consideration is likely to be the primary cause of adjacency misvotes. However, our findings hold regardless of which process drives adjacency misvotes.

examine how ballot design alters voting behavior and for which types of voters these effects are strongest. Following List and Reiley (2002), we assume that the rationality of voter behavior decreases with the cognitive cost of processing complicated ballot design. We examine how variation in cognitive costs across demographic groups can affect the probability of casting a misvote and thereby determine election outcomes. Our paper thus contributes to a relatively new literature that examines demographic variation in people's decision-making abilities in real world situations (e.g., Madrian 2001, Choi et al. 2004, Thaler and Benartzi 2004, and Lusardi and Mitchell 2006).

Second, misvotes can change election outcomes. Previous literature on position misvotes has predominantly focused on who gains from misvotes. King and Leigh (2006), Koppell and Steen (2004), and Miller and Krosnick (1998) show that candidates gain up to 2% in voteshare if they are listed near the start of the ballot. However, the gain from being listed near the top of the candidate list tends to be much smaller in well-publicized elections featuring party labels, and well-known or incumbent candidates (e.g., Ho and Imai 2006, Koppell and Steen 2004, Miller and Krosnick 1998, and Taebel 1975). Further, the bias caused by position misvotes can be minimized if the list of candidate names is randomized and rotated through voting districts as is done in states such as California, Ohio, and Kansas. Therefore, what often matters more for the outcome of major U.S. elections is which of the two front-runners systematically *loses* more votes to misvotes. This point is perhaps best illustrated by the unexpected large number of votes that Patrick Buchanan received on the "butterfly ballot" used in Palm Beach County, Florida during the 2000 U.S. Presidential Election. While even Buchanan himself acknowledges that most of the 3,407 votes he received in Palm Beach County are due to voter mistakes,[3] the bigger question is whether these misvotes came sufficiently more from Al Gore than from George Bush to overturn Bush's 537 vote margin of victory. Numerous studies using demographic trends and Buchanan's performance in surrounding counties indicate that this was likely the case (e.g., Wand et al. 2001, and Smith 2002).

Unlike position misvotes, adjacency misvotes can offer insight into differences in voteshare lost by major candidates. Voteshare gained by a candidate adjacent to a major candidate is voteshare lost by the associated major candidate. We assess which of the major candidates disproportionally loses votes to adjacent candidates in two ways. First, we examine whether minor candidates in the vicinity of one major candidate gain as much voteshare as minor candidates in the vicinity of another major candidate. Second, we relate the extent of misvoting in each election precinct to precinct demographic characteristics and estimate whether major candidates that appeal to voters with certain demographic characteristics lose more votes to adjacent candidates. To our knowledge we are the first study that does this for a major election, and both methods indicate that one of the major candidates disproportionally loses votes due to misvoting.

We measure adjacency misvoting by exploiting the rotational structure of ballots used in the 2003 California Recall Election. Candidates in the Recall Election are listed in order according to a randomized alphabetization in District 1, and then rotated one position at a time in subsequent districts. Due to the interaction between ballot rotation and each county's unique page layout, there exists significant exogenous variation in whether a minor (unpopular) candidate's name is adjacent to that of a major (popular) candidate. The increase in voteshare

[3] In an appearance on the "Today" show on November 9, 2000, Buchanan said, "When I took one look at that ballot on Election Night … it's very easy for me to see how someone could have voted for me in the belief they voted for Al Gore."

experienced by a minor candidate when she is adjacent to a major candidate is an estimate of adjacency misvoting. We then use precinct-level voting results and demographic data to test if certain demographic groups are more likely to cast misvotes than others. Finally, we test if, controlling for demographic characteristics, certain kinds of voting technologies correspond to a reduction in the level of misvoting.

The Recall Election has several desirable characteristics. First, California contains a large number of counties and districts that use a variety of voting technologies and ballot formats, allowing for maximal variation in whether a minor candidate is adjacent to a major candidate. Second, California rotates the long list of candidates (135 in total) one candidate at a time by district. This, again, allows for greater variation in terms of adjacency. Finally, a gubernatorial election is relatively important and well covered by the media and therefore may offer insights that can be extended to other major elections.

We find that the voteshares of minor candidates almost double when their names are adjacent to the names of major candidates. Misvotes account for at least 0.25 percent of all votes cast during the Recall Election.[4] We find that the amount of misvoting depends on the voting technology used; punch card technologies yield about twice the level of misvotes compared to optical scan and touch screen platforms, which confirms findings by Dee (2006). The amount of misvoting also varies with voter characteristics. Using precinct-level voter registration and Census data, we find that adjacency misvoting is strongest in precincts with high percentages of Democratic, Hispanic, low-income, non-English speaking, poorly educated, or young voters. After controlling for the relative popularities of the two major candidates, we find that the voteshare lost by the Democratic frontrunner, Cruz Bustamante exceeds the voteshare lost by his

[4] This is a lower bound because we only consider votes gained by candidates immediately adjacent to the top three frontrunners in our calculation of misvotes.

Republican rival, Arnold Schwarzenegger, by 63%. While Schwarzenegger beat Bustamante by a comfortable 17.0 percentage points in the Recall Election, the disproportionate misvoting would have given Schwarzenegger a 0.06% advantage if both had been tied at 47% of the vote. This margin is larger than the margins of victory in the 2000 U.S. presidential, 2004 Washington gubernatorial, 1974 New Hampshire senatorial, and 1985 Indiana representative elections. Schwarzenegger's advantage over Bustamante is also not much smaller than the margins of victory in several close U.S. elections including the 1880 and 1884 presidential elections and the 2000 Washington and 1998 Nevada senate elections, all of which had margins of victory of less than 0.1%.[5] Further, our estimate of the difference in voteshare lost by the major candidates underestimates the difference that might occur in elections in which two major candidates are adjacent to each other, as is the case in many U.S. presidential elections. In such situations, not only does one major candidate lose more votes to adjacent candidates, these losses are accrued by her opponent, thereby exacerbating differences in voteshare.

Adjacency misvotes pose a unique challenge to policy makers. While candidate list rotation by district can eliminate the bias posed by positional misvoting, rotation does nothing to reduce the bias caused by adjacency misvoting. No matter how a candidate list is randomized across districts, major candidates will continue to lose votes to adjacent candidates. Our results suggest two strategies that may reduce the level of adjacency misvotes. First, some voting technologies (electronic voting and certain brands of optical scan ballots) lead to lower levels of misvoting. Second, we find that adjacency misvotes are most prevalent when it is difficult to discern which candidate selection box is associated with a given candidate name. For example, on multi-column ballots, a single candidate name might be bordered by two selection bubbles.

[5] Of course, adjacency misvoting is also present in elections outside the United States. Differences in voteshare lost by major candidates could have determined outcomes for close international elections such as the 2006 Italian and Mexican General Elections, both of which were decided by less than 0.1% of the popular vote.

Thus, clearer separation of the selection boxes corresponding to each candidate's name may reduce the level of adjacency misvotes.

II. The California Recall Election Dataset

A statewide special election was held in California on October 7th 2003 concerning the recall of Governor Gray Davis. Voters were presented with two recall questions:

1. *"Should Gray Davis be recalled (removed) from the office of Governor?" Yes/No*
2. *Candidates to succeed Gray Davis as Governor if he is recalled: Vote for one"*
   [List of 135 names]

Voters were asked to respond to the second question regardless of their response to the first question. If more than 50% answer "Yes" to the first question, the candidate with the plurality of the vote on the second question becomes governor. Perhaps due to the low entry requirements (one needed only to obtain 65 signatures and pay the $3500 registration fee), a total of 135 candidates ran to replace Governor Gray Davis. The resulting candidate list was extremely diverse and included such personalities as actor Gary Coleman, erotic actress Mary "Mary Carey" Cook, and sumo wrestler Kurt E. "Tachikaze" Rightmyer.

Ballot format in the Recall Election was also extremely diverse. The ballot layout and technology was determined at the county level (58 counties). The ballot ordering of candidates varied by assembly district (80 districts). Because multiple counties can lie in the same district and vice versa, the Recall Election used 157 different ballots (county-district combinations). Candidates were ordered according to a randomized alphabet, "RWQOJMVAHBSGZXNTCIEKUPDYFL" in the first assembly district and then rotated one candidate at a time by district. Thus, in District 1, the order was alphabetical according to this randomly drawn alphabet: Robinson, Roscoe, Ramirez, …, Leonard. In District 2, Robinson becomes last, and all others move up by one. This rotation continued through all 80 districts.

Gray Davis was recalled as Governor of California (55% of voters voted to recall him). Table 1 shows the distribution of voteshares among the candidates running to replace him. The top three candidates captured a total 93.56% of the voteshare, leaving an average voteshare of 0.05% for the remaining 132 "minor" candidates. For the remainder of this paper, we consider the three frontrunners, Arnold Schwarzenegger (R), Cruz Bustamante (D), and Tom McClintock (R) as **major candidates**. Inclusion of the next most popular candidate, Peter Camejo, as a major candidate does not significantly change the baseline results. All candidates other than the top three are included in the analysis as **minor candidates**.[6]

California uses three types of voting technology platforms: punch card, optical scan, and touch screen. Punch card technology requires that voters use a stylus to punch out a pre-scored hole corresponding to the desired candidate. Some forms of punch card technology require that voters search for the candidate's number on a separate punch card grid while others place the pre-scored hole next to the candidate name. Optical scan technology requires that voters fill in an oval or other marking to the left or right of each candidate's name. Finally, touch screen technology requires that voters touch a box on the computer screen in order to select their desired candidate. After selection, the screen asks the voter to confirm her choice. Technology is determined at the county level. Approximately 40 percent of all counties use punch card, 40 percent use optical scan and 20 percent use touch screen technology. Each technology platform has several technology brands. The distribution of each brand is presented in Appendix 2.

[6] Results do not change significantly if (a) Peter Camejo is dropped from the dataset, (b) all observations representing minor candidates earning more than five percent of the voteshare in a precinct are dropped from the dataset, or (c) the definition of minor candidates is restricted to include only those candidates in the lower half of the voteshare distribution.

We utilize copies of sample ballots mailed to voters for 150 county-district combinations to code which candidates had which type of advantaged position in each count-district.[7] We obtain precinct-level statements of vote and registration data from the Institute of Governmental Studies (IGS) at the University of California, Berkeley. The statement of vote data has precinct-level vote tallies for every candidate.[8] The precinct-level registration dataset contains precinct-level (not individual-specific) registration data such as voter party registration, race, and age group. Because registration data does not include other important demographic variables such as income and education, we merge precinct-level data with U.S. Census data from 2000 at the blockgroup level using conversion files available from IGS. Summary statistics of these demographic variables are available in Appendix 2.

III. Empirical Strategy

In general, it is difficult to measure the level of adjacency misvotes because misvotes are recorded as valid votes. This may be the reason why previous literature (e.g., Alvarez et al. 2001 and Brady et al. 2001) has predominantly focused on the residual vote – votes that are discarded because of hanging chads or other mismarkings. To our knowledge, Dee's (2006) innovative paper is the only paper that analyzes adjacency misvotes directly. Dee argues that the positive correlation between the voteshares of a major candidate and the voteshares of "bookend candidates" – minor candidates listed immediately before or after the major candidate – is evidence of voting mistakes. Dee shows that voteshares of bookends increase by roughly 1/1000

[7] The actual ballots used during Election Day are identical in layout to the sample ballots. In the case of touch screen technology, voters viewed electronic screens which displayed candidate names in the same layout as that presented on the sample paper ballots. We have been unable to collect sample ballots from Stanislaus and Imperial Counties (which account for 1.4% of the vote).
[8] Precinct-level data from IGS is at present incomplete. Full statement of vote and registration data along with matching files account for 84% of all votes cast in the Recall Election.

of a percentage point for every percentage point increase in the adjacent major candidate's voteshare. However, Dee restricts his analysis to candidates who are almost always adjacent to major candidates and therefore cannot test voteshare gains caused by variation in when a minor candidate is adjacent to a major candidate. Thus, the critical assumption behind his results is that the voteshares of the four bookends are not correlated with the voteshares of major candidates due to reasons other than misvotes. However, this assumption may be reasonable in the context of Dee's paper, which focuses on which technologies mitigate misvoting rather than which demographic groups are most prone to misvoting and how misvotes can affect elections. Consistent with our findings, he finds that punch card technologies lead to significantly higher levels of misvoting.

To better capture variation in adjacency, we define an adjacent candidate as any minor candidate that vertically or horizontally borders a major candidate on a particular ballot (see sample ballots in Appendix 1). We call these adjacent candidates north, south, east, and west adjacent following a standard compass diagram. For example, the candidate directly above a major candidate is north adjacent. Identification of adjacency misvoting results from random variation in when a minor candidate is an adjacent candidate. North and south adjacent candidates are identified due to candidate name rotation through page and column breaks. Because north and south adjacent candidates are located in the same column as the major candidate, they are always present and the same unless column and page breaks cause the major candidate to be listed at the top or bottom of a column. For example, minor candidates Burton and Bly-Chester are listed before and after major candidate Bustamante according to the candidate name list. They are always north and south adjacent unless they are separated from Bustamante by a page or column break.

Identification of east and west adjacent candidates occurs because column length varies by county. In the sixty percent of counties that use multi-column ballots, the candidates horizontally adjacent to the major candidates depend on the county's column length. For example, if Schwarzenegger is listed in the middle column on a three-column ballot, he has east and west adjacent candidates. If Schwarzenegger is listed in the left-most column on a two-column ballot, he only has an east adjacent candidate. Further, this east adjacent candidate may not be the same east adjacent candidate as in the previous ballot if the two ballots have columns of differing lengths. Statistics describing the identification of each type of adjacent candidate are available in Appendix 2.[9]

Combining district-level candidate name rotation and county-level variation in ballot layout, we identify 68 minor candidates that are adjacent to a major candidate in some but not all county-districts. We use this variation to answer the following four questions:

1. *Is there evidence of voter irrationality as measured by increased voteshares of minor candidates located in favorable positions?*
2. *How does misvoting affect the relative voteshares of major candidates?*
3. *What demographic characteristics correlate with the amount of misvoting?*
4. *What voting technologies correspond to a reduction in the level of misvotes?*

To examine adjacency misvoting, we use the following baseline specification:

$$(1) \qquad Voteshare_{pdc} = \beta_0 + \beta_1 \times Adjacent_{pdcm} + controls + \varepsilon_{pdc}\,,$$

where

$$Adjacent_{pdcm} \equiv I_{dc}^{adjacent} \times Major\ Candidate\ Voteshare_{pdcm}$$

[9] We also identify a special class of adjacent candidates with numbers located in squares adjacent to the number corresponding to the major candidate on a punch card (See Appendix 1). These punch card adjacent candidates only exist in the 19% of counties that use the Votomatic or Pollstar brands of voting machines. Because column length in the punch card grid differs from column length in the ballot text, a candidate can be punch card adjacent without being adjacent on the regular ballot and vice versa.

An observation is a minor candidate c in a precinct p, with voting technology and ballot layout varying by county-district d. Each observation is weighted by the number of votes cast in precinct p.[10] $Voteshare_{pdc}$ is defined as the share of votes candidate c receives in precinct p in county-district d. We do not use the log of voteshare as the dependent variable because the voteshare gained by an adjacent candidate should be a level effect, and should not depend on the average voteshare of the minor candidate.[11] $I_{dc}^{adjacent}$ is a dummy variable equaling one if candidate c is adjacent to a major candidate in county-district d. In modifications of the baseline regression, $I_{dc}^{adjacent}$ may represent specific types of candidate adjacency (e.g., the minor candidate listed directly above major candidate Arnold Schwarzenegger) or a vector representing several types of candidate adjacency. If minor candidate c is adjacent to a major candidate in precinct p in county-district d, then $Major\ Candidate\ Voteshare_{pdcm}$ equals the voteshare in precinct p of the major candidate m to whom the minor candidate is adjacent. $Adjacent_{pdcm}$ is defined as the product of $I_{dc}^{adjacent}$ and $Major\ Candidate\ Voteshare_{pdcm}$. Finally ε_{pdc} is an error term that we allow to be clustered by county-district-candidate because the primary right hand side variable of interest, $I_{dc}^{adjacent}$, is constant within a county-district for a given minor candidate.

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[10] Weights account for the fact that an observation representing a large precinct is more precise because it is an average taken from a larger sample of voters. Thus, larger precincts should be weighted more heavily in the regression.

[11] This is verified empirically by a regression of minor candidate voteshare on a dummy variable equaling one if the minor candidate is adjacent to a major candidate and an interaction term between the dummy variable and the precinct-level voteshare of the minor candidate. The coefficient on the interaction term is insignificant and close to zero.

In the baseline specification, β_1 represents the gain in voteshare experienced by an adjacent minor candidate when the corresponding major candidate's voteshare increases by one. In other words, β_1 measures the percentage of voters originally intending to vote for a major candidate that end up voting for *each* adjacent minor candidate. (The total percentage of voters that misvote is not β_1 but rather the product of β_1 and the average number of minor candidates adjacent to major candidates per ballot.) Implicit in this interpretation of β_1 is that adjacency misvoting is a positive function of the popularity of the associated major candidate; i.e. if Schwarzenegger is more popular in precinct A than in precinct B and Schwarzenegger's voters are equally likely to misvote in precincts A and B, then candidates adjacent to Schwarzenegger should gain more voteshare in precinct A than in precinct B.

Our sample consists of observations at the candidate-precinct level. There are 132 data points per precinct, one for each minor candidate. This results in a total of 1,817,904 observations, covering 13,772 precincts corresponding to 80 districts and 55 counties.

We also introduce the following set of controls to the baseline regression and all extensions of the baseline regression: candidate ballot location controls (dummy variables for first and last on the ballot overall, ballot page, and ballot column), candidate fixed effects, candidate fixed effects interacted with demographic controls, and candidate fixed effects interacted with the voteshares of the major candidates.[12] Altogether, 2250 control variables are included in our baseline specification to ensure correct identification of adjacency misvoting.

The ballot location controls are county-district-candidate-level dummy variables that equal one if the minor candidate is located first or last overall, on a page, or in a column on the

[12] The addition of county-district fixed effect does not significantly change baseline results. They are omitted from the analysis in order to reduce computational demands on statistical software. Because the dependent variables sum to the total voteshare of minor candidates, county-district fixed effects only control for the relative popularity of all minor candidates compared to major candidates in each county-district.

ballot. These ballot position controls ensure that adjacency misvotes are not incorrectly identified off of position misvotes. The candidate fixed effects control for differences in the popularity of minor candidates that could lead to bias if relatively popular minor candidates happen to be adjacent to major candidates on a disproportionate share of the ballots. We also control for candidate fixed effects interacted with precinct-level demographic characteristics. This controls for how precinct-level demographic characteristics influence the popularity of each minor candidate. It ensures that adjacency misvoting is not incorrectly identified from precinct demographic characteristics, which, by chance, might favor candidates that are adjacent in that precinct. Similarly we control for candidate fixed effects interacted with the precinct-level voteshare of each major candidate to control for the correlation between the popularity of each minor candidate and the popularity of the major candidates.

In the Results section, we introduce several modifications of the baseline specification to check the robustness of the baseline results. We also further explore adjacency misvoting as it relates to voteshare lost by the major candidates, precinct-level demographic characteristics, and voting technology.

IV. Results

1. The Baseline Result

Regression (1) in Table 2 shows the results of the baseline specification. It is a least squares regression of precinct-level voteshares of each minor candidate on *Adjacent*, a variable equal to the voteshare of the associated major candidate if the minor candidate is adjacent to a major candidate and zero otherwise. Because voteshares of major candidates are expressed as fractions and voteshares of minor candidates as percentages, the coefficient on *Adjacent* represents the percentage of voters that misvote for each minor candidate adjacent to their preferred major candidate. Regression (1) reveals that each minor candidate adjacent to a major candidate will experience an increase in votes equal to 0.104% of the intended votes for that major candidate. This result is significant at the one percent level and is clear evidence of the bounded rationality of some voters.

Regression (2) in Table 2 decomposes adjacency misvoting by major candidate. It shows a regression of minor candidate voteshare on the interaction between *Adjacent* and a vector of dummy variables representing each major candidate. It shows that Bustamante loses 0.143% of his vote to each of his adjacent minor candidates, but that the corresponding figure is only 0.088% for Schwarzenegger and 0.107% for McClintock. This result is striking because it implies that Bustamante voters are 63% more likely to misvote than are Schwarzenegger voters. Thus, if Bustamante had received as high a voteshare as Schwarzenegger, Bustamante's adjacent candidates would have gained 63% more misvotes relative to Schwarzenegger's adjacent candidates. This result has important consequences because voteshare gained by an adjacent candidate is voteshare lost by the associated major candidate. In later regressions, we present evidence that Bustamante lost more votes than the other major candidates because he attracted voters from demographic groups associated with high levels of misvoting.

Regression (3) in Table 1 shows a variation of the baseline regression in which minor candidate voteshare is regressed on *Adjacent Dummy*, a dummy variable equaling one if a candidate is adjacent to a major candidate. The coefficient on *Adjacent Dummy* represents the average gain in voteshare a minor candidate experiences when she is adjacent to a major candidate. Results show that minor candidates gain 0.037 percentage points in voteshare if they are adjacent to a major candidate. Given that the average voteshare of minor candidates is 0.05%

percent, being adjacent to a major candidate nearly doubles a minor candidate's voteshare. A calculation taking into account the magnitude of adjacency misvoting for each type of adjacency (i.e. north, south, east, and west), along with the average number of adjacent candidates per ballot (see Appendix 3), reveals that misvotes accounted for at least 0.25% (SE=0.03%) of all votes cast in the Recall Election. Further, if Schwarzenegger and Bustamante had received equal shares of the votes received by the major candidates, misvotes would have given Schwarzenegger an edge of 0.06%.

Table 3 presents a series of regressions that support the robustness of our primary findings. Regression (1) in Table 3 shows a regression of minor candidate voteshare on *Adjacent Dummy*, a dummy variable equaling one if a minor candidate is adjacent to one of the major candidates and *Adjacent*, equal to the product of *Adjacent Dummy* and the precinct-level voteshare of an adjacent candidate's associated major candidate. Regression (1) tests our assumption that adjacent candidates gain voteshare as a positive function of the popularity of the major candidate. Results suggest that our assumption is valid – adjacent candidates earn only 0.010 percentage points in voteshare (a result that is not significantly different from zero at the 10% level) if they are adjacent to a major candidate that earns zero voteshare in a precinct. Further, adjacent candidates gain an additional 0.00082 percentage points for each additional percentage point gained by a major candidate. This result is significant at the 1% level.

Regression (2) in Table 3 tests that our primary results are driven by variation in when a candidate is adjacent to a major candidate rather than by variation in the voteshares of associated major candidates. Instead of regressing minor candidate voteshare on the product of an adjacency dummy and the *precinct-level* voteshares of associated major candidates, Regression (2) uses the product of an adjacency dummy and the *statewide* voteshares of the associated major candidates as the independent variable. By substituting statewide major candidate voteshare for precinct-level voteshare, we retain our assumption that adjacent candidates should gain more votes when they border more popular major candidates. However, now the only variation in the independent variable is caused by the adjacency of minor candidates to major candidates. The coefficient on *Adjacent Dummy×CA Voteshare* is 0.112 and significant at the 1% level. More importantly, it is very similar in magnitude to the coefficient of 0.104 on *Adjacent* in Regression (1) of Table 1, confirming that our results are driven by variation in the adjacency status of minor candidates.

Regression (3) in Table 3 decomposes adjacency misvoting by type of adjacency. We define a minor candidate to be adjacent if she borders a major candidate to the north, south, east or west. This regression shows that misvoting is strongest when a minor candidate is east adjacent and weakest when a minor candidate is west adjacent; 0.143% of voters misvote for east adjacent candidates, only 0.038% of voters misvote for west adjacent candidates, while 0.082% and 0.111% of voters misvote for north and south adjacent candidates respectively. We explore why east adjacent candidates gain more in voteshare than west adjacent candidates in our discussion of Regression (6). For now, we note that Regression (3) shows that adjacency misvoting is not driven merely by name confusion. One might think that voters vote for north and south adjacent candidates because candidates are listed in order (according to a randomized alphabet) down a column. For example, on the majority of ballots, the south adjacent candidate for Arnold Schwarzenegger is George Schwartzman. Voters may mistakenly vote for Schwartzman because his last name somewhat resembles "Schwarzenegger." We use candidate fixed effects to control for the direct effect of name confusion, but one might believe that it is the interaction between name confusion and adjacency that drives adjacency misvotes. However, east and west adjacent candidates are one column off from a major candidate and therefore have last names that are dissimilar to the names of their associated major candidates. The fact that these adjacent candidates also gain voteshare of comparable magnitude suggests that it is adjacency rather than name confusion that drives adjacency misvotes.

Regression (4) in Table 3 explores the voteshare gained by candidates that are diagonally adjacent to major candidates. Diagonally adjacent candidates are one row and one column off from their associated major candidate. Regression (4) shows that diagonally adjacent candidates earn much less in voteshare than candidates that are horizontally or vertically adjacent. 0.002% of voters misvote for each diagonally adjacent candidate compared to the 0.104% of voters that misvote for each vertically or horizontally adjacent candidate. Further, the coefficient on *Diagonally Adjacent* is not significant at the 10% level. Low voteshare gains for diagonally adjacent candidates likely occur because voters are less likely to misvote for candidates one row *and* one column removed from their intended choices. Because diagonally adjacent candidates gain very little in voteshare, we restrict our analysis to vertically or horizontally adjacent candidates.

Regressions (5) and (6) offer insight into what causes misvotes. We find that misvotes are primarily caused by accidental mistakes rather than the increased consideration voters may give to candidates adjacent to their preferred major candidates. Regression (5) in Table 3 explores misvoting for candidates adjacent to major candidates on punch cards. Nineteen percent of counties in California used punch card voting machines that require each voter to search for her desired candidate and that candidate's associated number from a booklet of candidate names. Each voter then punched out the desired candidate's number on a separate punch card. A sample punch card is provided in Appendix 1. Because the length of columns on the punch card differs from column length in the text ballot, a minor candidate can be punch card adjacent without being adjacent on a regular ballot and vice versa. The punch card lists only numbers, so voteshare gained by punch card adjacent candidates should represent gains due to voting mistakes. Voters are unlikely to first locate a preferred major candidate and then to give increased consideration to numbers adjacent to the major candidate's number if they do not see any names associated with those numbers. Regression (5) shows that, controlling for the adjacency of minor candidates on the regular ballot, 0.030% of voters misvote for each punch card adjacent candidate. This result is only significant at the ten percent level, perhaps because our limited observations involving punch card adjacency do not have enough power to yield significant results. Nevertheless, this result supports our hypothesis that adjacency misvotes do not derive only from increased consideration of adjacent candidates.

Regression (6) in Table 3 presents additional evidence that adjacency misvotes are driven by accidental votes rather than by increased consideration of adjacent candidates. We regress minor candidate voteshare on *Adjacent* and *Adjacent×Confusing Side*. *Confusing Side* is a dummy variable equaling one if the minor candidate is horizontally adjacent to a major candidate and listed in the column with selection boxes closest to the name of the major candidate. For example, in a single row, we might read from left to right: bubble, minor candidate, bubble, major candidate, bubble, minor candidate. See the figures in Appendix 1 for examples. In this case, the bubble for the east adjacent candidate is very close to the name of the major candidate and a voter may accidentally fill in the east adjacent candidate's bubble believing that she has cast a vote for the major candidate. Thus, confusing side equals one if a horizontally adjacent candidate is listed in a position that may be most confusing to the voter. After controlling for the effects of north and south adjacency, we find that the coefficient on *Horizontally Adjacent* is 0.031 while the coefficient on *Horizontally Adjacent×Confusing side* is 0.123. This implies that

0.031% of voters misvote for each horizontally adjacent candidates not on the confusing side while 0.031%+0.123%=0.154% of voters misvote for each horizontally adjacent candidate on the confusing side. Thus, voters are five times more likely to misvote for candidates listed on the confusing side. This implies that adjacency misvotes are, in large part, driven by accidental voting mistakes, because increased consideration should not depend on how each candidate's bubble is located relative to the major candidates. Regression (6) may also explain why the coefficient on *East Adjacent* is stronger than the coefficient on *West Adjacent* in Regression (3). For 63% of the multi-column ballots used in the Recall Election, selection boxes were placed to the left of each candidate's name. Therefore, the selection boxes of east adjacent candidates were usually closest to the names of the major candidates.

Regression (6) also delivers clear policy implications. Adjacency misvoting is extremely high in cases when it is ambiguous which selection boxes correspond to each candidate's name. Therefore, adjacency misvoting may be reduced if columns and rows are spaced farther apart, so that there is a clear separation between the each candidate's selection box and all other selection boxes.

2. Demographic Characteristics

The cognitive costs of voting, given complex ballot designs and voting technology, may be higher among certain demographic groups than others. This leads to systematic disadvantages for major candidates that attract groups more likely to misvote. Below, we show how the amount of misvoting varies with precinct-level demographic characteristics. We find that voters from precincts with high misvote rates disproportionally favored Democratic candidate Cruz Bustamante and that voter demographics may explain why Bustamante lost a higher proportion of his votes to adjacent candidates than did Schwarzenegger or McClintock.

A growing literature suggests that the level of residual votes, i.e. votes that are discarded because voters vote for more than one candidate, leave hanging chads, etc., depends on the racial and socioeconomic composition of each precinct. Tomz and Van Houweling (2003) use precinct-level data from South Carolina and Louisiana's 2000 Presidential Election to find that in areas with punch card or optically scanned ballots, the Black-White gap in residual voteshare ranged from four to six percentage points. In comparison, lever and touch screen machines cut the gap in residual voteshares by a factor of ten. Tomz and Van Houweling do not control for income, education, and other demographic variables in their analysis. However, even controlling for socioeconomic differences, the racial gap remains significant. Knack and Kropf (2003) use county-level data from the 1996 Presidential Election to find that counties with more Black or Hispanic voters have higher residual vote tallies, controlling for income, education and voting technology.

To our knowledge, no research has yet explored how the prevalence of misvoting varies by demographic characteristics. To test how misvoting varies by precinct-level demographic characteristics, we interact the variable *Adjacent* with precinct-level demographic characteristics $Demo_{pd}$, and add this interaction to the baseline specification.[13] If $Demo_{pd}$ represents a single variable, then the coefficient on $Adjacent \times Demo_{pd}$ represents the additional gain in voteshare caused by adjacency misvoting when $Demo_{pd}$ and all other demographic variables positively correlated with $Demo_{pd}$ increases. Meanwhile, if $Demo_{pd}$ represents a vector of demographic characteristics, the coefficients on $Adjacent \times Demo_{pd}$ represent the marginal change in the gain in voteshare caused by adjacency misvotes for an increase in each demographic variable, holding the other measured demographic variables constant. This distinction is important in cases in

[13] The direct effect of $Demo_{pd}$ is absorbed by the $Demo_{pd} \times$*candidate fixed effects* interactions that are already included in the baseline specification.

which the partial effect differs from the overall change. For example, we find that adjacency misvoting is stronger in precincts with many registered Democrats. However, this overall effect is driven by the fact that many registered Democrats have other characteristics (such as less education) that may cause them to make more voting mistakes. If we hold these characteristics constant, we find that the partial effect of a greater percentage of registered Democrats does not increase misvoting.

When exploring the impact of demographic characteristics on adjacency misvoting, we use the same set of controls as in baseline specification. In addition, we control for $Demo_{pd}$, $Tech_d$ and $Adjacent \times Tech_d$ where $Tech_d$ is a vector of technology dummy variables representing the brand of technology used in each county-district. The controls for technology ensure that our demographic estimates are not biased because of a possible correlation between precinct-level demographic characteristics and the voting technology of the precinct's corresponding county.

There are two caveats to the demographic results. First, even if a demographic characteristic such as low education is correlated with higher levels of misvoting, lack of education may not be the cause of adjacency misvotes. For example, it is conceivable that education is positively correlated with experience taking standardized exams, and experience with standardized exams is what truly reduces levels of misvoting. Second, the ecological fallacy, as explained by Achen and Shively (1995), states that analysis using precinct-level data does not necessarily imply direct links between *individual* demographics characteristics and the magnitude of adjacency misvoting. For example, a regression might show that a precinct with a 60% Asian and 40% White population casts misvotes at a higher rate than does a precinct with a 10% Asian population and a 90% White population. This does not necessarily imply that Asian voters are more likely to cast misvotes. It could instead be the case that the White voters who choose to live in predominantly Asian precincts cast misvotes at a higher rate. Nevertheless, we argue that precinct-level demographic data offers important insights. Precinct-level demographic data reveal which types of precincts exhibit stronger adjacency misvoting.

Regression (1) in Table 4 shows that a one percentage point increase in the number of voters with a high school degree corresponds to a 0.0062 percentage point fall in the percentage of voters that misvote for each adjacent candidate. This result is significant at the five percent level. The coefficient on *Adjacent×%College Graduates* is similar with value of -0.0056, suggesting that, holding high school education constant, college education has no additional impact on misvoting. Thus, precincts with high percentages of high school graduates (including college graduates) cast significantly fewer misvotes. The calculations in the last three columns of Table 4 show the difference in the percentage of voters that vote for each adjacent candidate for precincts at the 5^{th} percentile of a demographic variable compared to precincts at the 95^{th} percentile. Holding the fraction with a college education constant, the percentage of voters that misvote for each adjacent candidate is 0.22 percentage points lower in precincts at the 95^{th} percentile of high school education than in precincts at the 5^{th} percentile. This difference is double the average percentage of voters that misvote for each adjacent candidate. This result is consistent with evidence from Lusardi and Mitchell (2006) and Benjamin et al. (2006). Lusardi and Mitchell also find that lack of education is a strong predictor of making mistakes, but in the context of simple questions about interest, inflation and risk diversification. Benjamin et al. present experimental evidence that lower cognitive ability, rather than lack of schooling per se, is a powerful predictor of behavioral anomalies.

Regression (2) in table 4 shows that, holding the percentage of precinct residents that are Black and Asian constant, a one percentage point increase in the number of Hispanic residents corresponds to a 0.0038 percentage point increase in the percentage of voters that misvote for each adjacent candidate. This result is significant at the one percent level. Meanwhile, the coefficients on *Adjacent×%Black* and *Adjacent×%Asian* are small with standard errors near zero, implying that precincts with high percentages of Black or Asian residents do not behave significantly differently from precincts with high percentages of White residents (the omitted category). Holding the percentage of Black and Asian residents constant, the percentage of voters that misvote for each adjacent candidate is 0.23 percentage points higher in precincts at the 95th percentile of percent Hispanic than in precincts at the 5th percentile. This difference is also double the average percentage of voters that misvote for each adjacent candidate.

Regression (3) in table 4 shows how misvoting varies by the party registration of voters. The coefficients on *Adjacent×%Republican* and *Adjacent×%Independent* are -0.0025 and -0.0068, respectively, while the coefficient on *Adjacent×%Other Party* is not significantly different from zero. Since the omitted category is *%Democrat*, these results show that precincts with high percentages of Republican or Independent voters misvote at significantly lower rates than precincts with high percentages of Democratic or Other Party voters. A one percentage point increase in the number of registered Republicans corresponds to a 0.0025% point fall in the percentage of voters that misvote for each adjacent candidate. Holding the percentage of Independent and Other Party voters constant, the percentage of voters that misvote for each adjacent candidate is 0.128 percentage points lower in precincts at the 95th percentile of percent Republican than in precincts at the 5th percentile. Similarly, holding the percentage of Republican and Other Party constant, the percentage of voters that misvote for each adjacent candidate is 0.170 percentage points lower in precincts at the 95th percentile of percent

Independent than in precincts at the 5th percentile. These differences are greater than the average percentage of voters that misvote for each adjacent candidate.

Table 5 presents regressions exploring how adjacency misvotes vary with five other precinct-level demographic variables: median household income in thousands of U.S. dollars, percent living below the Census poverty line, percent lacking English fluency, percent over the age of 65, and percent between the ages of 18 and 24. All specifications show a significant coefficient on the interaction term, $Adjacent \times X$ where X represents the demographic characteristic of interest. These coefficients imply that precincts with high percentages of residents between the ages of 18 and 24, living below the poverty line, or lacking fluency in English[14] exhibit higher levels of misvoting. Precincts with high percentages of residents above the age of 65 also exhibit higher levels of misvoting, although the effect is smaller than for the other characteristics.[15] Conversely, precincts with high median household income exhibit low levels of misvoting. Calculations in the last three rows of Table 5 estimate the difference in the magnitude of adjacency misvoting between precincts at the 5th and 95th percentile in terms of X, the demographic variable of interest. These calculations reveal that differences in these demographic characteristics correspond to large changes in the magnitude of adjacency misvoting. The results for low income precincts are consistent with Madrian and Shea (2001), Choi et al. (2004), and Thaler and Benartzi (2004), who in different settings, find that lower-

[14] We also test how the relationship between the percentage of voters lacking English fluency and adjacency misvoting changes conditional on the availability of foreign language ballots. During the Recall Election, 80% of precincts offered Spanish ballots while 40% of precincts offered ballots in at least one Asian language. Results show that adjacency misvoting is stronger in precincts that offer Spanish ballots. In addition, the availability of foreign language ballots does not significantly change the relationship between English fluency and adjacency misvotes. However, it is difficult to draw causal conclusions from these results because the availability of foreign language ballots is endogenously determined by each county.

[15] Age 65 was chosen as the cutoff because voter registration data does not distinguish age groups for ages greater than 65. Voter registration data may provide a better estimate of actual voter demographics than Census data because a higher percentage of registered voters vote on Election Day. However, results do not significantly change using older age cutoffs derived from Census data.

income employees are more likely to conform to the default savings options by their employers, which is likely because these employees have a higher cognition cost of making the optimal savings decisions.

Table 6 shows the results of a regression of minor candidate voteshare on *Adjacent* and the interaction between *Adjacent* and a vector of precinct-level demographics. The coefficients on the interaction terms are partial effects; they represent the change in the magnitude of adjacency misvoting for a change in a single demographic characteristic when the other demographic characteristics are held constant. We find that the partial effect of the percentage of registered Democrats is not significantly different from the partial effects of other political affiliations.[16] Altogether, the demographic interactions show that misvoting increases with the fraction Hispanic or Asian, the fraction elderly and the fraction in poverty, while it decreases with the fraction with at least a high school degree, and the fraction lacking English fluency.[17]

These demographic trends shed light on why, relative to Schwarzenegger and McClintock, Bustamante lost more votes to adjacent candidates. If the three candidates had been equally popular, Bustamante would have lost 63% more votes than Schwarzenegger and 34% more votes than McClintock. Using demographic trends, we estimate how much of the difference in voteshare lost by each major candidate can be accounted for by differences in the demographic characteristics of each major candidate's voting base.[18] We find that, compared to

[16] The percentage of voters registered with the Democratic Party is negatively correlated with median household income and the percentage of residents with high school diplomas, both of which are associated with lower levels of misvoting. This explains why the percentage of registered democratic voters has a positive overall effect on misvoting (Table 4) but a non-significant partial effect (Table 6).

[17] The percentage of voters lacking English fluency is negatively correlated with income and education. Further, over 80% of voters had access to foreign language ballots. This may explain why the percentage of voters lacking English fluency has a positive overall effect on misvoting (Table 5) but a negative partial effect (Table 6).

[18] We first estimate the number of misvotes cast in each precinct using each precinct's demographic characteristics. The estimated number of misvotes in each precinct multiplied by each major candidate's performance in a precinct (as a fraction of the total votes for the three major candidates) is an estimate of the number of misvotes lost by each major candidate. After adjusting for the relative popularities of the major candidates, we find that demographic

Schwarzenegger and McClintock, Bustamante attracted voters most likely to misvote. Differences in the observed demographic characteristics of each major candidate's voting base can explain roughly one half of the difference in voteshare lost. Our calculation is actually a lower bound for the explanatory power of demographic characteristics. Since our data is at the precinct level, we need to assume that, within a precinct, Schwarzenegger, Bustamante, and McClintock voters are equally likely to misvote for adjacent candidates. This is likely to be false – within a precinct, Bustamante voters are probably more likely to cast misvotes. Therefore, we underestimate the extent to which demographic characteristics can account for differences in voteshares lost by the major candidates.

3. Voting Technology

Numerous studies and policy initiatives have explored the effect of voting technology on the number of discarded ballots, also known as residual votes. These studies consistently find that, relative to optical scan and electronic technology platforms, the punch card technology platform is associated with the greatest number of residual votes. Brady et al. (2001) summarizes the current research relating to voting technology. On average, residual votes account for two percent of all votes in presidential races. Using county-level data from the 2000 U.S. Presidential Election, Brady et al. find that touch screen and optical scan voting technology yield half the level of residual votes found in elections using punch card technology. Alvarez et al. (2001) employ similar methods to find results generally consistent with those of Brady et al.

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characteristics predict that Bustamante lost 24% more votes than Schwarzenegger and 19% more votes than McClintock. Thus demographic characteristics can account for at least 39% of the difference in votes lost by Bustamante and Schwarzenegger and 57% of the difference in votes lost by Bustamante and McClintock.

While numerous studies have explored the relationship between technology and the residual vote, much less research has explored the relationship between technology and adjacency misvotes. Dee (2006) finds that punch card technology increases the voteshare gained by "bookend" candidates, i.e. candidates vertically adjacent to major candidates. Using county-level data from the 2003 California Recall election, Dee shows that, relative to touch screen and optical scan technology, punch card technology increases the voteshare of bookends by 0.04 percentage points on average, an increase of more than one-third of the mean voteshare of the bookends. We extend Dee's analysis to a precinct-level dataset that measures adjacency misvotes based upon variation in when candidates are vertically and horizontally adjacent to major candidates. We also extend Dee's analysis by exploring whether technology differences are driven by platforms (i.e. punch card) or by individual technology brands. Further, we control for precinct-level demographic characteristics – this will better control for the possibility that technology is correlated with demographic characteristics that influence misvoting.

To study the relationship between technology and adjacency misvoting, we interact the variable *Adjacent* with a vector of technology dummies $Tech_d$ representing technology platforms or technology brands. We add this interaction and $Tech_d$ itself to the baseline specification. By platform of technology, we refer to broad categories of technology such as touch screen, punch card, or optical scan technology. By brands of technology, we refer to specific brands of voting machines, e.g., the Diebold AccuVote-TS that uses the touch screen technology platform. For a summary of the availability of each type of technology, see Appendix 1. In addition to the large set of controls included in the baseline regression, we now add controls for $Adjacent \times Demo_{pd}$, where $Demo_{pd}$ is a vector of precinct-level demographic variables. This specification controls for the possibility that voting technology is correlated with precinct-level demographic variables and separates technology effects from demographic effects.

Regression (2) in Table 7 shows the relationship between voting technology platform and adjacency misvoting. Our results indicate that 0.197% of voters using punch card technology misvote for each adjacent candidate compared to only 0.100% and 0.065% of voters using optical scan and touch screen technology respectively. Further, the coefficient on *Adjacent*×*Punch Card* is significantly different from the coefficients on *Adjacent*×*Optical Scan* and *Adjacent*×*Touch Screen* at the five percent level. These results suggest that touch screen and optical scan technology cut the prevalence of misvoting roughly in half relative to punch card technology. This result is consistent with the large literature (e.g., Alvarez et al. 2001 and Brady et al. 2001) arguing that punch card technology causes the greatest number of residual votes. After all, residual votes are examples of detected voting mistakes while adjacency misvotes are largely undetected voting mistakes.

Regression (4) in Table 7 shows the relationship between the brand of voting technology and the magnitude of adjacency misvoting. Eleven brands of voting technology were used during the Recall Election. Each brand corresponded to one of three technology platforms: optical scan, touch screen, or punch card. Further details concerning the distribution of technology brands are included in Appendix 1. Results from Regression (2) reveal that, controlling for the impact of demographic characteristics, brands tend to have the same rate of misvoting within each technology class, with three notable exceptions: the optical scan Diebold Accu-Vote-OS has a level of misvoting that is comparable to typical punch card voting technologies, the punch card Datavote brand has a level of misvoting that is comparable to most optical scan and touch screen technologies,[19] and the touch screen Diebold AccuVote-TS is associated with an insignificantly low level of misvoting.

Results from regressions (2) and (4) are very similar to results from regression (1) and (3) in which we do not control for precinct demographic characteristics. This supports evidence by Knack and Kropf (2002), Garner and Spalaore (2005), and Card and Moretti (2005) showing that areas with low levels of education and income, and high levels of Black or Hispanic voters are not more likely to have "inferior" technologies such as punch card voting. Of course, it is possible that precincts in counties that choose to adopt each brand of voting technology have other characteristics not already accounted for by the demographic controls that influence the magnitude of adjacency misvoting. We cannot simply conclude that touch screen technology is "better" than punch card technology because technology may be endogenously chosen. However, the technology brand analysis does suggest that a simple switch away from the punch card technology platform may not automatically reduce the level adjacency misvoting. Careful consideration of inter-brand differences may be necessary.

4. Applications and Extensions

While the small but significant loss of votes to adjacent candidates did not change the outcome of the Recall Election, it may have important implications for elections in general. Numerous presidential, senatorial, and gubernatorial elections have been determined by very slim margins of victory. The margins of victory of the popular vote in the Presidential Elections

[19] The Datavote punch card brand distinguishes itself from the other two punch card brands in that it allows voters to punch out their selections on the regular ballots (rather than requiring the use of punch card ballots in addition to regular text ballots). Thus, the low level of misvotes associated with the Datavote machine suggests that the act of "punching" out pre-scored holes may not be the cause of misvoting. Instead, higher levels of misvoting associated with punch card technology by may be driven by the use of separate punch card ballots.

of 1880, 1884, 1960, and 2000 were all less than one-quarter of a percent.[20] Recently, the 2004 Washington gubernatorial, 2000 Washington senatorial, 1998 Nevada senatorial, and 2002 South Dakota senatorial elections were determined by voteshare margins of less than one-tenth of a percent. Major candidates that attract voters that are more likely to cast misvotes would suffer key disadvantages in these close elections.

However, one may wonder if results from California's gubernatorial recall election can be applied to other major elections. The Recall Election was unique in that it featured an unusually large number of candidates, 135 in total, competing in a single race. The advantage is that the large number of candidates combined with variation in ballot layout and candidate order provides the best available identification of adjacency misvoting. The disadvantage is that most major elections feature far fewer candidates competing in a single race. For example, while a total of 72 candidates ran for President in at least one state during the 2004 Election, the majority of states listed fewer than ten candidates. Even primary elections, known for their large candidate pools, typically feature fewer than thirty candidates per race.[21] This does not imply, however, that the California Recall Election ballots were unusually confusing. Ballots used in major elections contain numerous races (e.g., President, Senate, House, assembly district, county, municipality, etc.) and propositions, and thus do not significantly differ in length or complexity from Recall Election ballots. However, adjacency misvoting may depend on the length of the candidate list for a single race. Therefore, future research may wish to explore whether misvoting occurs at comparable levels in elections featuring fewer candidates.

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[20] Outcomes of presidential elections are officially determined by the Electoral College. For a majority of U.S. states, the popular vote by state determines how state electoral votes are distributed in the Electoral College. In each of the presidential elections listed above, the margin of victory was less than a quarter of a percent in the popular vote of at least one state with enough electoral votes to determine the outcome of the election.

[21] Data for presidential elections and primaries are drawn from state election websites.

Future nationwide studies of adjacency misvoting may be particularly beneficial because adjacency misvoting could have a large impact on major elections outside of California. Unlike California, many states in the U.S. do not rotate candidate name order on ballots. Rather, incumbents are listed first, followed by a long list of minor candidates. This implies that the candidate adjacent to a major candidate could be another major candidate. If this is the case, votes lost by one major candidate are systematically accrued by another major candidate. For example, suppose that, relative to the Republican frontrunner, the Democratic frontrunner attracts voters that are more likely to cast misvotes. Further suppose that the two frontrunners are adjacent to each other on the ballot. Then the Democratic frontrunner would not only lose more votes to adjacent candidates. Her loss would actually go to her opponent, thereby magnifying her electoral disadvantage.

V. Conclusion

This paper tests the hypothesis that minor candidates experience gains in voteshare when their names are listed near the name of a major candidate on a ballot. We refer to votes for minor candidates resulting from adjacency misvoting as "misvotes" because ballot layout should not impact the voting choices of fully rational voters with negligible cognition costs.

We test adjacency misvoting using a unique dataset combining precinct-level voting results from the 2003 California Recall Election with precinct-level Census and voter registration data. Because ballot layout and candidate order are determined at the county-district level, there exists random variation in when a minor candidate is adjacent to a major candidate. The gain in the total voteshares experienced by minor candidates that are adjacent is an estimate of the number of misvotes. We find that the voteshares of minor candidates almost double when their names are adjacent to the names of major candidates and that misvotes accounted for at least 0.25% percent of all votes cast during the Recall Election. Misvotes are most prevalent in precincts with high percentages of Democratic, Hispanic, low-income, non-English speaking, poorly educated, or young voters, suggesting that these groups may face higher cognitive costs of voting. We also find that, relative to the punch card technology platform, the use of the optical scan or touch screen technology platforms generally corresponds to a reduction in the number of misvotes. However, even within technology platforms, there are some notable performance differences across voting machine brands.

Adjacency misvoting has important electoral implications because votes gained by adjacent candidates are votes lost by major candidates. A major candidate that attracts voters from precincts that cast high levels of misvotes suffers systematic electoral disadvantages. In the case of the California Recall Election, precincts that were most affected by adjacency misvoting also showed the strongest support for Democratic candidate Cruz Bustamante. This may explain why, relative to Republican candidate Arnold Schwarzenegger, Bustamante lost 63 percent more of the votes intended for him to his adjacent candidates. Although this difference in lost votes represents a small fraction of the total voteshare, the loss exceeds the margins of victory in several recent elections, including the presidential election of 2000 and the Washington gubernatorial election of 2004. Thus, adjacency misvoting is powerful enough to determine outcomes in important highly-contested close elections.

References

Achen, Christopher H. and W. Phillips Shively. 1995. *Cross Level Inference*. Chicago: University of Chicago Press.

Alvarez, Michael R., et al. 2001. *Voting: What is, What Could Be*. Caltech/MIT Voting Technology Project.

Benjamin, Daniel J., Sebastian A. Brown, and Jesse M. Shapiro. May 2006. "Who is 'Behavioral'? Cognitive Ability and Anomalous Preferences." SSRN Electronic Paper 675264.

Brady, Henry E., et al. 2001. *Counting All the Votes: The Performance of Voting Technology in the United States*. Department of Political Science, Survey Research Center, and Institute of Governmental Studies, University of California, Berkeley.

Card, David and Enrico Moretti. May 2005. "Does Voting Technology Affect Election Outcomes? Touch-Screen Voting and the 2004 Presidential Election." NBER Working Paper 11309.

Choi, James, David Laibson, Brigitte Madrian, and Andrew Metrick. 2004. "For Better or For Worse: Default Effects and 401(k) Savings Behavior" in David Wise editor, *Perspectives in the Economics of Aging.* Chicago, IL: University of Chicago Press, 81-121.

Conlisk, John. 1996. "Why bounded rationality?" *Journal of Economic Literature* 34(2): 669-700.

Dee, Thomas S. June 2006. "Technology and Voter Intent: Evidence from the California Recall Election." *Review of Economics and Statistics*, forthcoming.

Garner, Phillip and Enrico Spolaore. 2005. "Why Chads? Determinants of Voting Equipment Use in the United States." *Public Choice* 123: 363-392.

Ho, Daniel E. and Kosuke Imai. (2006). "Randomization Inference With Natural Experiments: An Analysis of Ballot Effects in the 2003 California Recall Election." *Journal of the American Statistical Association* 101(475): 888-900.

Knack, Stephen and Martha Kropf. 2002. "Who Uses Inferior Voting Technology?" *Political Science and Politics* 35(3): 541-548.

Knack, Stephen and Martha Kropf. 2003. "Voided Ballots in the 1996 Presidential Election: A County-Level Analysis." *Journal of Politics* 65(3): 881-897.

Koppell, Jonathan G.S. and Jennifer A. Steen. 2004. "The Effects of Ballot Position on Election Outcomes." *Journal of Politics* 66(1): 267-281.

King, Amy and Andrew Leigh. September 2006. "Ballot Order Effects Under Compulsory Voting." Unpublished Manuscript. University of South Australia and Australian National University.

List, John A. and David Lucking-Reiley. 2002. "Bidding Behavior and Decision Costs in Field Experiments." *Economic Inquiry* 40(4): 611-619.

Lusardi, Annamaria and Olivia S. Mitchell. 2006. "Financial Literacy and Planning: Implications for Retirement Wellbeing." Unpublished manuscript. Dartmouth College.

Madrian, Brigitte C. and Dennis F. Shea. 2001. "The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior." *Quarterly Journal of Economics* 116(4): 1149-1187.

Miller, Joanne M. and Jon A. Krosnick. 1998. "The Impact of Candidate Name Order on Election Outcomes." *The Public Opinion Quarterly* 62(3): 291-330.

Roth, Susan K. 1998. "Disenfranchised by Design: Voting Systems and the Election Process." *Information Design Journal* 9(1): 1-8.

Simon, Herbert A. 1955. "A Behavioral Model of Rational Choice." *Quarterly Journal of Economics* 69(1): 99-118.

Smith, Richard L. 2002. "A Statistical Assessment of Buchanan's Vote in Palm Beach County." *Statistical Science* 17(4): 441-457.

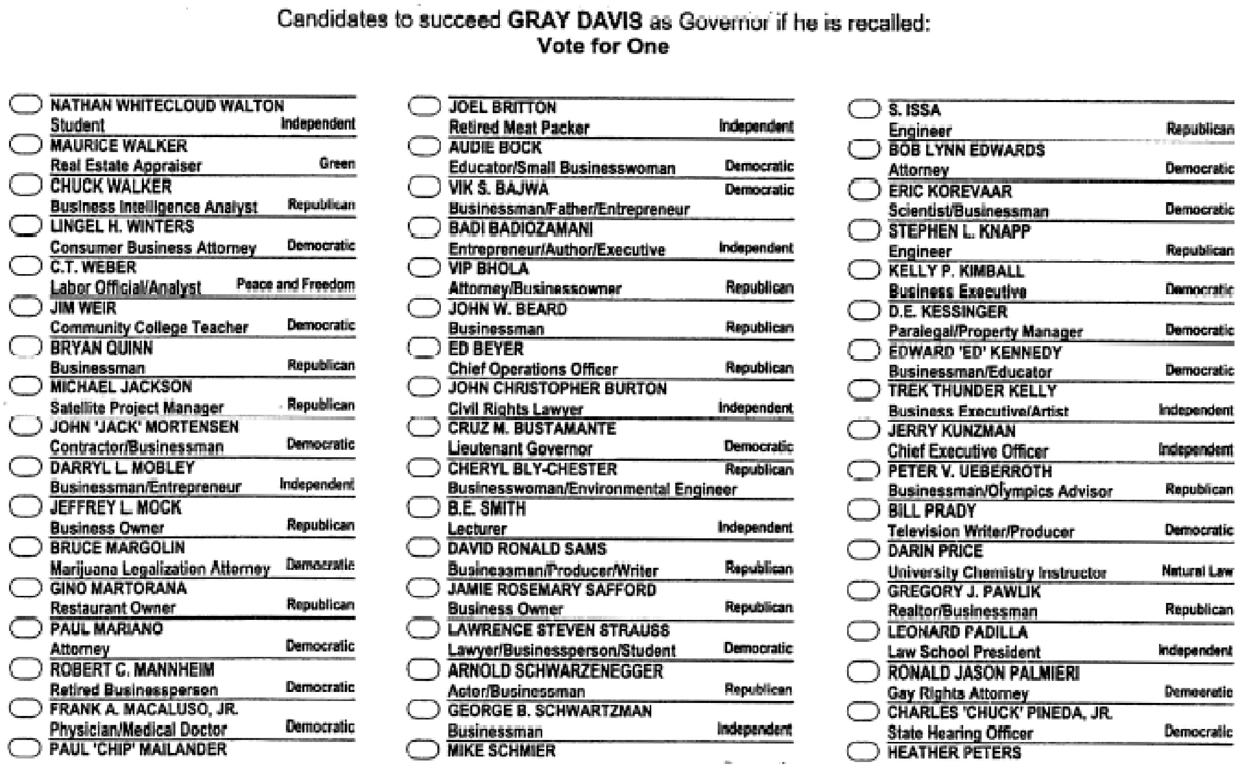
Taebel, Delbert A. 1975. "The Effect of Ballot Position on Electoral Success." *American Journal of Political Science* 19(3): 519-526.

Thaler, Richard H. and Shlomo Benartzi. 2004. "Save More Tomorrow™: Using Behavioral Economics to Increase Employee Saving." *Journal of Political Economy* 112(1, pt. 2): S164-S187.

Tomz, Michael and Robert P. Van Houweling. 2003. "How Does Voting Equipment Affect the Racial Gap in Voided Ballots?" *American Journal of Political Science* 47(1): 46-60.

Wand, Jonathan W., et al. 2001. "The Butterfly Did It: The Aberrant Vote for Buchanan in Palm Beach." *American Political Science Review* 95(4): 793-810.

Appendix 1: Sample Ballots

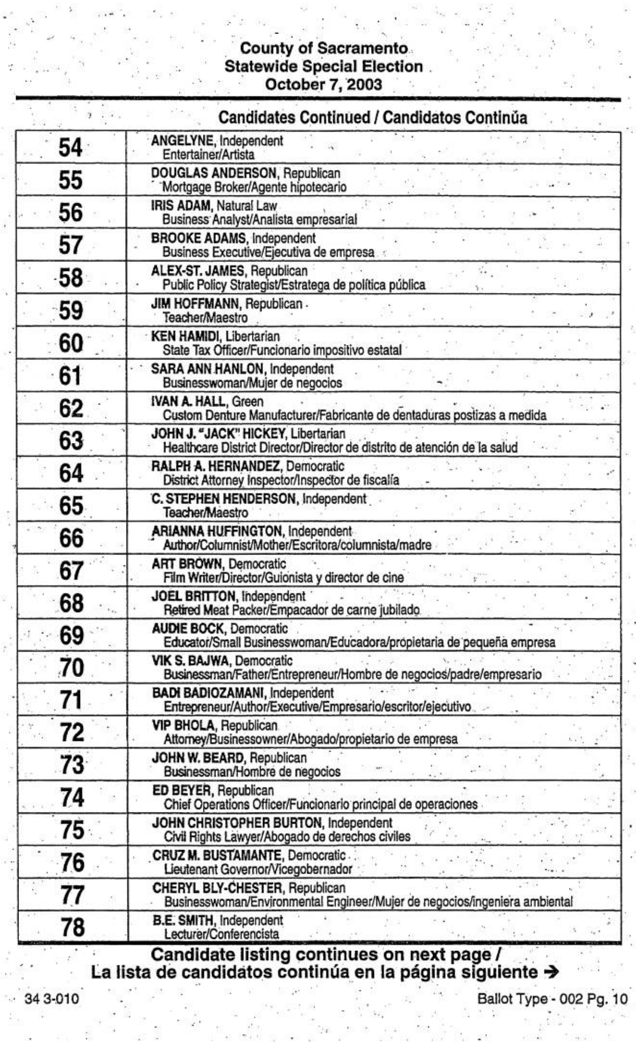

Candidates to succeed GRAY DAVIS as Governor if he is recalled:
Vote for One

NATHAN WHITECLOUD WALTON — Student — Independent
MAURICE WALKER — Real Estate Appraiser — Green
CHUCK WALKER — Business Intelligence Analyst — Republican
LINGEL H. WINTERS — Consumer Business Attorney — Democratic
C.T. WEBER — Labor Official/Analyst — Peace and Freedom
JIM WEIR — Community College Teacher — Democratic
BRYAN QUINN — Businessman — Republican
MICHAEL JACKSON — Satellite Project Manager — Republican
JOHN 'JACK' MORTENSEN — Contractor/Businessman — Democratic
DARRYL L. MOBLEY — Businessman/Entrepreneur — Independent
JEFFREY L. MOCK — Business Owner — Republican
BRUCE MARGOLIN — Marijuana Legalization Attorney — Democratic
GINO MARTORANA — Restaurant Owner — Republican
PAUL MARIANO — Attorney — Democratic
ROBERT C. MANNHEIM — Retired Businessperson — Democratic
FRANK A. MACALUSO, JR. — Physician/Medical Doctor — Democratic
PAUL 'CHIP' MAILANDER

JOEL BRITTON — Retired Meat Packer — Independent
AUDIE BOCK — Educator/Small Businesswoman — Democratic
VIK S. BAJWA — Businessman/Father/Entrepreneur — Democratic
BADI BADIOZAMANI — Entrepreneur/Author/Executive — Independent
VIP BHOLA — Attorney/Businessowner — Republican
JOHN W. BEARD — Businessman — Republican
ED BEYER — Chief Operations Officer — Republican
JOHN CHRISTOPHER BURTON — Civil Rights Lawyer — Independent
CRUZ M. BUSTAMANTE — Lieutenant Governor — Democratic
CHERYL BLY-CHESTER — Businesswoman/Environmental Engineer — Republican
B.E. SMITH — Lecturer — Independent
DAVID RONALD SAMS — Businessman/Producer/Writer — Republican
JAMIE ROSEMARY SAFFORD — Business Owner — Republican
LAWRENCE STEVEN STRAUSS — Lawyer/Businessperson/Student — Democratic
ARNOLD SCHWARZENEGGER — Actor/Businessman — Republican
GEORGE B. SCHWARTZMAN — Businessman — Independent
MIKE SCHMIER

S. ISSA — Engineer — Republican
BOB LYNN EDWARDS — Attorney — Democratic
ERIC KOREVAAR — Scientist/Businessman — Democratic
STEPHEN L. KNAPP — Engineer — Republican
KELLY P. KIMBALL — Business Executive — Democratic
D.E. KESSINGER — Paralegal/Property Manager — Democratic
EDWARD 'ED' KENNEDY — Businessman/Educator — Democratic
TREK THUNDER KELLY — Business Executive/Artist — Independent
JERRY KUNZMAN — Chief Executive Officer — Independent
PETER V. UEBERROTH — Businessman/Olympics Advisor — Republican
BILL PRADY — Television Writer/Producer — Democratic
DARIN PRICE — University Chemistry Instructor — Natural Law
GREGORY J. PAWLIK — Realtor/Businessman — Republican
LEONARD PADILLA — Law School President — Independent
RONALD JASON PALMIERI — Gay Rights Attorney — Democratic
CHARLES 'CHUCK' PINEDA, JR. — State Hearing Officer — Democratic
HEATHER PETERS

The image above shows the upper portion of a multi-column optical scan ballot used in Alameda County. Consider major candidate Arnold Schwarzenegger, located in the middle column, third from the bottom. Because the columns are not clearly separated by boundary lines, voters intending to vote for Schwarzenegger may accidentally fill in the bubble corresponding to Ronald Palmieri, Schwarzenegger's east adjacent candidate, instead of the correct bubble to the left of Schwarzenegger's name.



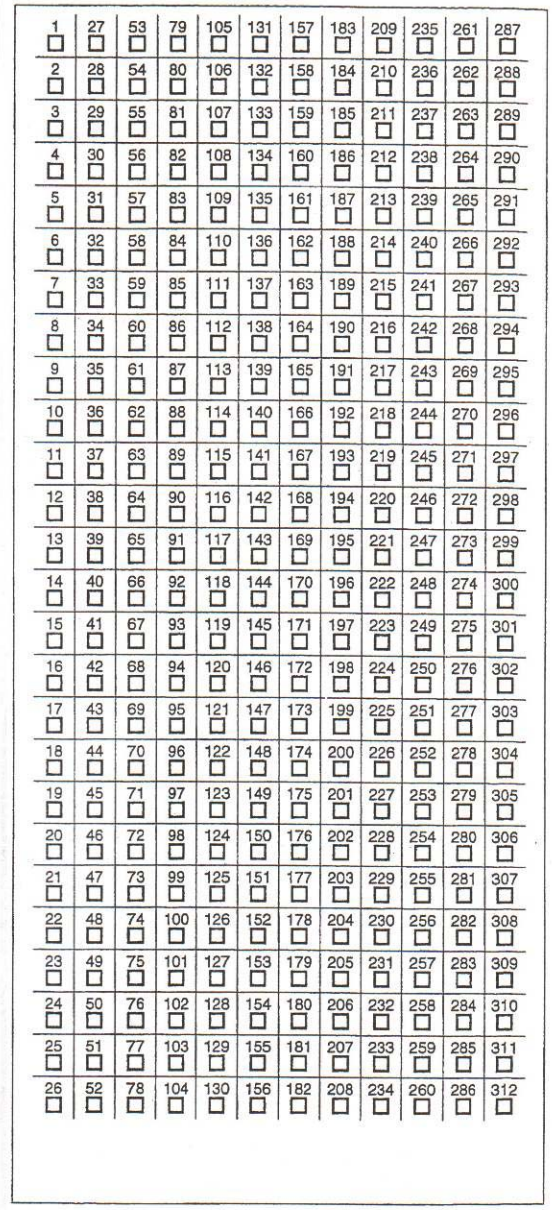
County of Sacramento
Statewide Special Election
October 7, 2003

Candidates Continued / Candidatos Continúa

54	ANGELYNE, Independent Entertainer/Artista
55	DOUGLAS ANDERSON, Republican Mortgage Broker/Agente hipotecario
56	IRIS ADAM, Natural Law Business Analyst/Analista empresarial
57	BROOKE ADAMS, Independent Business Executive/Ejecutiva de empresa
58	ALEX-ST. JAMES, Republican Public Policy Strategist/Estratega de política pública
59	JIM HOFFMANN, Republican Teacher/Maestro
60	KEN HAMIDI, Libertarian State Tax Officer/Funcionario impositivo estatal
61	SARA ANN HANLON, Independent Businesswoman/Mujer de negocios
62	IVAN A. HALL, Green Custom Denture Manufacturer/Fabricante de dentaduras postizas a medida
63	JOHN J. "JACK" HICKEY, Libertarian Healthcare District Director/Director de distrito de atención de la salud
64	RALPH A. HERNANDEZ, Democratic District Attorney Inspector/Inspector de fiscalía
65	C. STEPHEN HENDERSON, Independent Teacher/Maestro
66	ARIANNA HUFFINGTON, Independent Author/Columnist/Mother/Escritora/columnista/madre
67	ART BROWN, Democratic Film Writer/Director/Guionista y director de cine
68	JOEL BRITTON, Independent Retired Meat Packer/Empacador de carne jubilado
69	AUDIE BOCK, Democratic Educator/Small Businesswoman/Educadora/propietaria de pequeña empresa
70	VIK S. BAJWA, Democratic Businessman/Father/Entrepreneur/Hombre de negocios/padre/empresario
71	BADI BADIOZAMANI, Independent Entrepreneur/Author/Executive/Empresario/escritor/ejecutivo
72	VIP BHOLA, Republican Attorney/Businessowner/Abogado/propietario de empresa
73	JOHN W. BEARD, Republican Businessman/Hombre de negocios
74	ED BEYER, Republican Chief Operations Officer/Funcionario principal de operaciones
75	JOHN CHRISTOPHER BURTON, Independent Civil Rights Lawyer/Abogado de derechos civiles
76	CRUZ M. BUSTAMANTE, Democratic Lieutenant Governor/Vicegobernador
77	CHERYL BLY-CHESTER, Republican Businesswoman/Environmental Engineer/Mujer de negocios/ingeniera ambiental
78	B.E. SMITH, Independent Lecturer/Conferencista

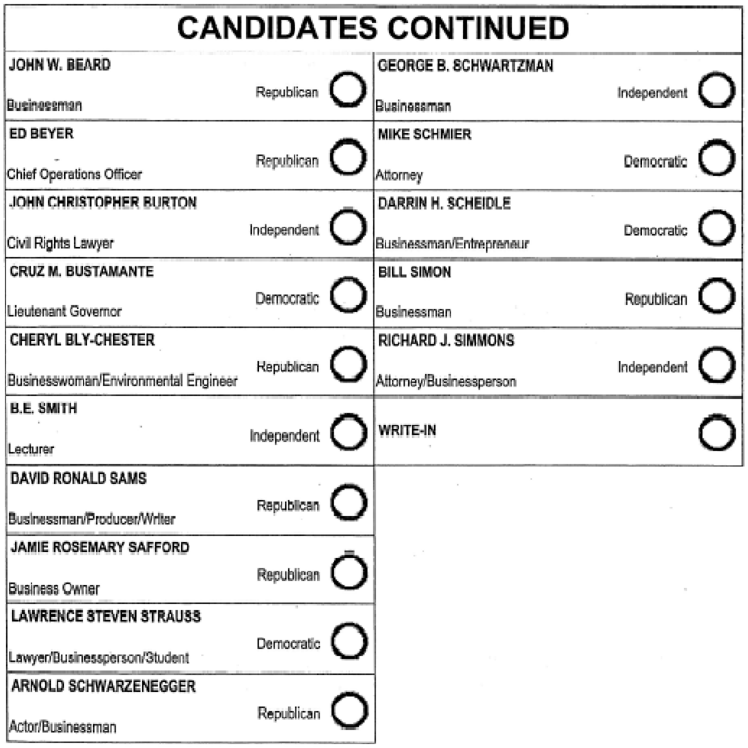
Candidate listing continues on next page /
La lista de candidatos continúa en la página siguiente →

34 3-010 Ballot Type - 002 Pg. 10



1	27	53	79	105	131	157	183	209	235	261	287
2	28	54	80	106	132	158	184	210	236	262	288
3	29	55	81	107	133	159	185	211	237	263	289
4	30	56	82	108	134	160	186	212	238	264	290
5	31	57	83	109	135	161	187	213	239	265	291
6	32	58	84	110	136	162	188	214	240	266	292
7	33	59	85	111	137	163	189	215	241	267	293
8	34	60	86	112	138	164	190	216	242	268	294
9	35	61	87	113	139	165	191	217	243	269	295
10	36	62	88	114	140	166	192	218	244	270	296
11	37	63	89	115	141	167	193	219	245	271	297
12	38	64	90	116	142	168	194	220	246	272	298
13	39	65	91	117	143	169	195	221	247	273	299
14	40	66	92	118	144	170	196	222	248	274	300
15	41	67	93	119	145	171	197	223	249	275	301
16	42	68	94	120	146	172	198	224	250	276	302
17	43	69	95	121	147	173	199	225	251	277	303
18	44	70	96	122	148	174	200	226	252	278	304
19	45	71	97	123	149	175	201	227	253	279	305
20	46	72	98	124	150	176	202	228	254	280	306
21	47	73	99	125	151	177	203	229	255	281	307
22	48	74	100	126	152	178	204	230	256	282	308
23	49	75	101	127	153	179	205	231	257	283	309
24	50	76	102	128	154	180	206	232	258	284	310
25	51	77	103	129	155	181	207	233	259	285	311
26	52	78	104	130	156	182	208	234	260	286	312

The images above show a single-column ballot and a punch card grid used in Sacramento County. Voters searched for the number corresponding to the desired candidate's name using standard text ballots. Each voter then used a stylus to punch out the desired candidate's number on a separate punch card grid. The small print suggests voters may accidentally punch out numbers corresponding to candidates adjacent to major candidates on the punch card.



CANDIDATES CONTINUED

JOHN W. BEARD Businessman	Republican	GEORGE B. SCHWARTZMAN Businessman	Independent
ED BEYER Chief Operations Officer	Republican	MIKE SCHMIER Attorney	Democratic
JOHN CHRISTOPHER BURTON Civil Rights Lawyer	Independent	DARRIN H. SCHEIDLE Businessman/Entrepreneur	Democratic
CRUZ M. BUSTAMANTE Lieutenant Governor	Democratic	BILL SIMON Businessman	Republican
CHERYL BLY-CHESTER Businesswoman/Environmental Engineer	Republican	RICHARD J. SIMMONS Attorney/Businessperson	Independent
B.E. SMITH Lecturer	Independent	WRITE-IN	
DAVID RONALD SAMS Businessman/Producer/Writer	Republican		
JAMIE ROSEMARY SAFFORD Business Owner	Republican		
LAWRENCE STEVEN STRAUSS Lawyer/Businessperson/Student	Democratic		
ARNOLD SCHWARZENEGGER Actor/Businessman	Republican		

The image above shows a multi-column touch screen ballot used in Riverside County. Voters selected their desired candidates by touching the desired candidates' corresponding circles. A second screen then asked voters to confirm their choices. This ballot also shows how column breaks allow identification of vertically adjacent candidates. Minor candidate George Schwartzman normally follows major candidate Arnold Schwarzenegger in the candidate list. However, Schwartzman is not south adjacent on this ballot because he is separated from Schwarzenegger by a column break.

Appendix 2: Summary Statistics

Precinct Level Data

Variable	Mean	Std. Dev.
Statement of Vote and Voter Registration Data		
total votes cast in precinct	852	585
% voteshare of a minor candidate	0.05	0.35
% voteshare for Arnold Schwarzenegger	48.3	17.0
% voteshare for Cruz Bustamante	31.8	17.7
% voteshare for Tom McClintock	13.5	4.8
% registered with the Democratic Party	40.1	12.4
% registered with the Republican Party	38.6	15.1
% registered with other political parties	6.5	8.4
% not registered with any political party	15.0	6.0
% age 18 to 24	8.1	4.9
% age 65 plus	19.0	10.8
Census Demographic Data		
% White	68.3	19.4
% Black	4.9	8.9
% Asian	10.5	11.5
% Hispanic	22.1	19.1
% lacking english fluency	7.7	8.5
median household income ($1000 per year)	28.0	14.1
% below the Census poverty line	11.0	10.6
% high school graduates (not incl. college graduates)	43.5	10.9
% college graduates	39.4	18.1
Observations:	1,817,904	
Precincts:	13,772	

Observations are at the candidate-precinct-level. Observations do not include the top three voteshare earners. Means and standard deviations are weighted by the total number of votes cast in each precinct.

Identification of Adjacent Candidates

	Frequency: % of precincts with ballots that contain this type of adjacency			**Variation:**
Type	Schwarzenegger adjacent	Bustamante adjacent	McClintock adjacent	number of minor candidates that occupy the adjacent position
north adjacent	93.7	96.8	94.1	3
south adjacent	92.1	96.0	92.6	3
east adjacent	35.6	39.0	35.5	25
west adjacent	23.4	26.5	15.6	19
punchcard adjacent	10.9	10.9	10.9	18

When calculating frequency, observations are weighted by the total number of votes cast in each precinct. This is done because observations are weighted by precinct size in all regression specifications.

Voting Technology

Technology Brand	Technology Platform	Prevalence	Used Again in 2005 Election
Diebold Accu-Vote-OS	optical scan	12%	Yes
ES&S 550 Optech	optical scan	5%	No
ES&S Optech Eagle	optical scan	5%	Yes
Hart Ballot Now	optical scan	11%	Yes
Mark-A-Vote	optical scan	3%	Yes
Sequoia Optech	optical scan	6%	Yes
Diebold AccuVote-TS	touch screen	5%	Yes
Sequoia Edge	touch screen	6%	Yes
Datavote	punch card	6%	Yes
Pollstar	punch card	9%	No
Votomatic	punch card	31%	No

Prevalence is defined as the percentage of observations in which each brand of technology is used. When calculating prevalence, observations are weighted by the total number of votes cast in each precinct. Brands listed with a “Yes” in column four were used again by at least one county in the statewide elections in 2005.

Appendix 3: Calculation of the Number of Misvotes

Results from the regression, $Voteshare_{pdc} = B_0 + \boldsymbol{B_1} \times \boldsymbol{I_{dc}}^{\boldsymbol{adjacent}} + controls + \varepsilon_{pdc}$, can be used to estimate the total number of misvotes cast by voters in the Recall Election. Let $\boldsymbol{I_{dc}}^{\boldsymbol{adjacent}}$ represent a vector of adjacency dummy variables,

$$(I^{north\ AS\ adjacent}, I^{south\ AS\ adjacent}, I^{east\ AS\ adjacent}, I^{west\ AS\ adjacent}, I^{north\ CB\ adjacent}, I^{south\ CB\ adjacent}, I^{east\ CB\ adjacent}, I^{west\ CB\ adjacent}, I^{north\ TM\ adjacent}, I^{south\ TM\ adjacent}, I^{east\ TM\ adjacent}, I^{west\ TM\ adjacent}).$$

By separately measuring adjacency misvoting for each major candidate and adjacency type, we identify the unique gain in voteshare when, for example, a candidate is north adjacent to Arnold Schwarzenegger. This distinction is necessary because not all types of adjacency exist with equal frequency.

Let $\boldsymbol{F}$ be a vector equal to:

$$(F^{north\ AS\ adjacent}, F^{south\ AS\ adjacent}, F^{east\ AS\ adjacent}, F^{west\ AS\ adjacent}, F^{north\ CB\ adjacent}, F^{south\ CB\ adjacent}, F^{east\ CB\ adjacent}, F^{west\ CB\ adjacent}, F^{north\ TM\ adjacent}, F^{south\ TM\ adjacent}, F^{east\ TM\ adjacent}, F^{west\ TM\ adjacent}).$$

For example, $F^{north\ AS\ adjacent}$ represents the average number of minor candidates that are located directly north of Arnold Schwarzenegger, weighted by the total votes cast in a precinct. In a given precinct, Schwarzenegger either has no north adjacent candidates (if Schwarzenegger is at the top of a ballot column) or one north adjacent (if Schwarzenegger is not at the top of a ballot column). Since $\boldsymbol{F}$ is an average across all precincts, $\boldsymbol{F}$ ranges between 0 and 1. One can think of $\boldsymbol{F}$ as correcting for the fact that adjacent candidates exist with unequal frequency. For example, north and south adjacent candidates always exist unless the major candidate is at the top or bottom of a column respectively. However, east and west adjacent candidates only exist on multi-column ballots. See Appendix 2 for detailed frequency statistics.

If $\boldsymbol{\beta_1}$ is the coefficient vector derived from the regression specified above, misvotes as a percentage of total votes cast is equal to $\boldsymbol{\beta_1 F}$. A simple calculation reveals that $\boldsymbol{\beta_1 F}$ equals 0.25 with a standard error of 0.03. Thus misvotes accounted for 0.25% of all votes cast in the 2003 California Recall Election.

Tables

Table 1: 2003 California Recall Election Results

Rank	Candidate	Voteshare	No. Votes
1	Arnold Schwarzenegger	48.6	3,747,446
2	Cruz M. Bustamante	31.63	2,439,133
3	Tom McClintock	13.33	1,027,926
4	Peter Miguel Camejo	2.77	213,547
5	Arianna Huffington	0.55	42,654
6	Peter V. Ueberroth	0.29	22,267
7	Larry Flynt	0.2	15,489
8	Gary Coleman	0.16	12,712
9	George B. Schwartzman	0.14	10,960
10	Mary Cook	0.13	10,129
:			
:			
25	Edward Thomas Kennedy	0.0335	2,586
50	Michael J. Wozniak	0.0179	1,384
75	Scott A. Mednick	0.0103	791
100	Dennis Duggan McMahon	0.0067	517
135	Todd Richard Lewis	0.0022	172

Table 2: Primary Results

Dependent Variable: *Voteshare* = (votes / total votes)×100	**(1)**	**(2)**	**(3)**
Adjacent	0.104** (0.018)		
Adjacent × Schwarzenegger		0.088** (0.025)	
Adjacent × Bustamante		0.143** (0.025)	
Adjacent × McClintock		0.107* (0.045)	
Adjacent Dummy			0.037** (0.006)
Observations	1,817,904	1,817,904	1,817,904
R-Squared	0.8676	0.8676	0.8676

Robust standard errors, adjusted for clustering on county×district×candidate (19,800 clusters), are reported in parentheses. Significance levels: +: 10 percent; *: 5 percent; **: 1%. *Adjacent* equals one multiplied by the precinct level voteshare of the associated major candidate if a minor candidate is adjacent to a major candidate and zero otherwise. *Schwarzenegger*, *Bustamante*, and *McClintock* are dummy variables that equal one if a minor candidate is adjacent to major candidates Schwarzenegger, Bustamante, and McClintock respectively. Observations are weighted by the total number of votes cast in a precinct. Controls are included for candidate fixed effects, candidate fixed effects interacted with demographic controls (%Black, %Hispanic, %Asian, %age 18-24, %age 65 plus, %in poverty, median household income (in $1000 per year), %HS graduates, %college graduates, %Democrat, %Republican, %other party affiliation, %independent, and %lacking English fluency), candidate fixed effects interacted with the precinct-level voteshares of major candidates Schwarzenegger, Bustamante, and McClintock and ballot position controls (dummy variables for first and last overall, on a ballot page, and in a ballot column) representing the ballot position of the minor candidate in each county-district.

Table 3: Robustness Checks

Dependent Variable: *Voteshare* = (votes / total votes)×100	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Adjacent	0.082**			0.104**	0.113**	
	(0.027)			(0.018)	(0.018)	
Adjacent Dummy	0.010					
	(0.007)					
Adjacent Dummy × CA Voteshare		0.112**				
		(0.019)				
North Adjacent			0.082**			0.082**
			(0.022)			(0.022)
South Adjacent			0.111**			0.111**
			(0.033)			(0.033)
East Adjacent			0.143**			
			(0.035)			
West Adjacent			0.038**			
			(0.011)			
Diagonally Adjacent				0.002		
				(0.003)		
Punchcard Adjacent					0.030+	
					(0.018)	
Horizontally Adjacent						0.031**
						(0.008)
Horizontally Adjacent × Confusing Side						0.123**
						(0.038)
Observations	1,817,904	1,817,904	1,817,904	1,817,904	1,817,904	1,817,904
R-Squared	0.8676	0.8676	0.8677	0.8676	0.8677	0.8677

Robust standard errors, adjusted for clustering on county×district×candidate, are reported in parentheses. Significance levels: +: 10 percent; *: 5 percent; **: 1%. If a minor candidate is adjacent to a major candidate, *CA voteshare* equals the average statewide of the associated major candidate. *North, South, East,* and *West Adjacent* equal one multiplied by the precinct-level voteshare of the associated major candidate if a minor candidate is north, south, east, or west adjacent respectively and zero otherwise. *Diagonally Adjacent* and *Punch card Adjacent* equal one multiplied by the precinct-level voteshare of the associated major candidate if a minor candidate diagonally borders a major candidate (i.e. is listed to the northeast, northwest, southeast, or southwest of a major candidate) or is adjacent to a major candidate on a punch card, respectively. *Horizontally Adjacent* equals the precinct level voteshare of the associated major candidate if a minor candidate is east or west adjacent and zero otherwise. *Confusing Side* is a dummy variable equaling one if the minor candidate is horizontally adjacent to a major candidate and listed in the column with selection boxes closest to the name of the major candidate. All other controls and variables are as described in Table 2.

Table 4: Overall Effect of Precinct Demographic Characteristics on Misvoting

Dependent Variable: *Voteshare =* (votes / total votes)×100	**(1)**	**(2)**	**(3)**	5th Percentile	95th Percentile	Difference in Adjacency Effect
Adjacent	0.6368** (0.1012)	0.0544** (0.0162)	0.3353** (0.0467)			
Adjacent × % HS Graduates	-0.0062** (0.0013)			24%	60%	-0.223
Adjacent × % College Graduates	-0.0056** (0.0010)			12%	71%	-0.330
Adjacent × % Black		0.0005 (0.0009)		0%	18%	0.009
Adjacent × % Hispanic		0.0038** (0.0008)		4%	65%	0.232
Adjacent × % Asian		0.0003 (0.0006)		1%	36%	0.011
Adjacent × % Republican			-0.0025** (0.0007)	9%	60%	-0.128
Adjacent × % Other Party			0.0000 (0.0020)	3%	21%	0.000
Adjacent × % Independent			-0.0068** (0.0016)	0%	25%	-0.170
Observations	1,817,904	1,817,904	1,817,904			
R-Squared	0.8680	0.8680	0.8679			

Robust standard errors, adjusted for clustering on county×district×candidate, are reported in parentheses. Significance levels: +: 10 percent; *: 5 percent; **: 1%. Omitted Categories: *%HS dropouts, %other ethnicity, %Democrat*. *%HS graduates* and *%college graduates* represent the percentage of precinct residents with high school degrees and college degrees *(%HS graduates* does not include those who have also graduated from college). *%Black, Hispanic, Asian* represent the percentage of precinct residents that identify themselves as Black, Hispanic, or Asian respectively (the omitted group includes White and other ethnicities). *%Democrat*, *%Republican*, and *%Other Party* represent the percentage of registered voters that are officially registered as a Democrat, Republican, or other party member; all remaining voters are included in *%Independent*. Controls are included for $Tech_d$ and $Adjacent_{pdcm} \times Tech_d$ where $Tech_d$ is a vector of dummy variables representing the 11 brands of voting technology used in the Recall Election. All other controls and variables are as described in Table 2.

Table 5: Overall Effect of Precinct Demographic Characteristics on Misvoting (continued)

Dependent Variable: *Voteshare* = (votes / total votes)×100	**(1)** ***X* =** ***Income (K)***	**(2)** ***X* =** ***% In Poverty***	**(3)** ***X* =** ***% Lacking English Fluency***	**(4)** ***X* =** ***% Age 65 Plus***	**(5)** ***X* =** ***% Age 18 to 24***
Adjacent	0.2328**	0.0964**	0.0891**	0.1240**	0.1024**
	(0.0321)	(0.0126)	(0.0155)	(0.0163)	(0.0153)
Adjacent × X	-0.0033**	0.0041**	0.0073**	0.0007*	0.0045**
	(0.0006)	(0.0009)	(0.0013)	(0.0003)	(0.0015)
Observations	1,817,904	1,817,904	1,817,904	1,817,904	1,817,904
R-Squared	0.8679	0.8679	0.8679	0.8679	0.8679
5th Percentile of X	12K	1%	0%	7%	3%
95th Percentile of X	55K	33%	27%	35%	14%
Difference in Adjacency Effect	-0.1419	0.1312	0.1971	0.0196	0.0495

Robust standard errors, adjusted for clustering on county×district×candidate, are reported in parentheses. Significance levels: +: 10 percent; *: 5 percent; **: 1%. *Income* represents median household income of precinct residents in $1000 per year. *%In Poverty* represents the percentage of households in a precinct below the census poverty line. *%Lacking English Fluency* represents the percentage of precinct residents lacking fluency in English. *%Age 65 Plus* and *%Age 18 to 24* represents the percentage of registered voters in a precinct above the age of 65 and between the ages of 18 and 24 respectively. All other controls and variables are as described in Table 4.

Table 6: Partial Effect of Precinct Demographic Characteristics on Misvoting

Dependent Variable: *Voteshare* = (votes / total votes)×100		
Adjacent	0.7046**	(0.1554)
Adjacent × % Black	-0.0001	(0.0009)
Adjacent × % Hispanic	0.0022+	(0.0012)
Adjacent × % Asian	0.0014*	(0.0007)
Adjacent × % Age 18-24	-0.0015	(0.0011)
Adjacent × % Age 65 Plus	0.0012*	(0.0005)
Adjacent × % In Poverty	0.0010*	(0.0005)
Adjacent × Income (K)	-0.0002	(0.0005)
Adjacent × % HS Graduates	-0.0086**	(0.0023)
Adjacent × % College Graduates	-0.0068**	(0.0017)
Adjacent × % Republican	0.0010	(0.0011)
Adjacent × % Other Party	0.0041+	(0.0023)
Adjacent × % Independent	-0.0004	(0.0016)
Adjacent × % Lacking English Fluency	-0.0066*	(0.0031)
Observations	1,817,904	
R-Squared	0.8680	

Robust standard errors, adjusted for clustering on county×district×candidate, are reported in parentheses. Significance levels: +: 10 percent; *: 5 percent; **: 1%. Omitted Categories: *%Other Ethnicity, %HS Dropouts*, *%Democrat*. All other controls and variables are as described in Tables 4 and 5.

Table 7: Interactions with Voting Technology

	Dependent Variable: *Voteshare* = (votes / total votes)×100	**(1)**	**(2)**	**(3)**	**(4)**
	Adjacent × punch card	0.197**	0.200**		
		(0.020)	(0.019)		
	Adjacent × optical scan	0.100**	0.108**		
		(0.020)	(0.019)		
	Adjacent × touch screen	0.065**	0.067**		
		(0.016)	(0.015)		
Optical	***Adjacent × Diebold Accu-Vote-OS***			0.178**	0.175**
				(0.041)	(0.034)
	Adjacent × ES&S 550 Optech			0.061**	0.082**
				(0.015)	(0.018)
	Adjacent × ES&S Optech Eagle			0.076**	0.108**
				(0.018)	(0.027)
	Adjacent × Hart Ballot Now			0.046**	0.065**
				(0.015)	(0.014)
	Adjacent × Mark-A-Vote			0.065*	0.074**
				(0.026)	(0.027)
	Adjacent × Sequoia Optech			0.106**	0.095**
				(0.024)	(0.023)
Touch	***Adjacent × Diebold AccuVote-TS***			0.015	0.008
				(0.023)	(0.033)
	Adjacent × Sequoia Edge			0.099**	0.095**
				(0.020)	(0.017)
Punch	***Adjacent × Datavote***			0.088**	0.095**
				(0.025)	(0.024)
	Adjacent × Pollstar			0.225**	0.241**
				(0.035)	(0.035)
	Adjacent × Votomatic			0.207**	0.212**
				(0.019)	(0.018)
	Demographic Controls	No	Yes	No	Yes
	Observations	0.8677	0.8679	0.8679	0.8680
	R-Squared	1,817,904	1,817,904	1,817,904	1,817,904

Robust standard errors, adjusted for clustering on county×district×candidate, are reported in parentheses. Significance levels: +: 10 percent; *: 5 percent; **: 1%. Controls are included for the direct effect of each technology variable. Demographic controls include $Adjacent_{pdcm} \times Demo_{pd}$ where $Demo_{pd}$ is a vector of precinct-level variables representing %Black, %Hispanic, %Asian, %age 18-24, %age 65 plus, %in poverty, median household income (K), %HS graduates, %college graduates, %Democrat, %Republican, %other party affiliation, %independent, and %lacking English fluency. All other variables and controls are as described in Table 2.